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FORTY-SECOND ANNUAL REPORT

Fiscal Year Ending June 30, 1931

OF THE

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN



M. J. FUNCHESS, *Director*
AUBURN, ALABAMA

Contents

Transmittals	3
Trustees	4
Station Staff	4
New Publications	5
Agricultural Economics	8
Agricultural Engineering	11
Agronomy and Soils	13
Animal Husbandry, Dairying, and Poultry	22
Botany and Plant Pathology	46
Entomology	47
Home Economics	49
Horticulture and Forestry	50
Special Investigations	54
Veterinary Medicine	55

TRANSMITTALS

Alabama Polytechnic Institute
Auburn, Alabama

President Bradford Knapp
Auburn, Alabama

Dear Doctor Knapp:

I have the honor to submit herewith the Forty-Second Annual Report of the Agricultural Experiment Station of the Alabama Polytechnic Institute.

Yours very truly,

M. J. Funchess,
Director.

Alabama Polytechnic Institute
Auburn, Alabama

Governor B. M. Miller
Montgomery, Alabama

Dear Sir:

I take pleasure in transmitting to you the Forty-Second Annual Report of the Agricultural Experiment Station of the Alabama Polytechnic Institute.

Yours very truly,

Bradford Knapp,
President.

ALABAMA POLYTECHNIC INSTITUTE

COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

TRUSTEES

His Excellency, B. M. Miller, President	Ex Officio
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Charles Henderson (Second District)	Troy
H. H. Conner (Third District)	Eufaula
T. D. Samford (Third District)	Opelika
H. D. Merrill (Fourth District)	Anniston
Harry Herzfeld (Fifth District)	Alexander City
J. A. Rogers (Sixth District)	Gainesville
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C. W. Ashcraft (Eighth District)	Florence
Victor H. Hanson (Ninth District)	Birmingham
P. S. Haley (Tenth District)	Oakman

B. L. Shi, Secretary

EXPERIMENT STATION STAFF

Bradford Knapp, B. S., L. L. B., D. Agr., President
M. J. Funchess, M. S., Director of Experiment Station
W. H. Weidenbach, B. S., Executive Secretary
P. O. Davis, B. S., Agricultural Editor
Mary E. Martin, Librarian
Sara Willeford, Agricultural Librarian

Agricultural Economics:

*J. D. Pope, M. S.	Agricultural Economist
B. F. Alvord, M. S.	Associate Agricultural Economist
*C. G. Garman, B. S.	Assistant Agricultural Economist
C. M. Clark, M. S.	Assistant in Agricultural Economics
P. A. Taylor, B. S.	Assistant in Agricultural Economics
Edith M. Slights	Statistical Assistant

Agricultural Engineering:

M. L. Nichols, M. S.	Agricultural Engineer
J. W. Randolph, M. S.	Agricultural Engineer (Coop. U. S. D. A.)
A. Carnes, M. S.	Assistant Agricultural Engineer
N. W. Wilson, B. S.	Assistant Agricultural Engineer
E. Diseker, B. S.	Assistant in Agricultural Engineering
H. D. Sexton, B. S.	Graduate Assistant

Agronomy and Soils:

M. J. Funchess, M. S.	Agronomist
J. W. Tidmore, Ph. D.	Soil Chemist
Anna L. Sommer, Ph. D.	Associate Soil Chemist
**F. L. Davis, M. A.	Assistant Soil Chemist
G. D. Scarseth, B. S.	Assistant Soil Chemist
H. B. Tisdale, M. S.	Associate Plant Breeder
J. T. Williamson, B. S.	Associate Agronomist
R. Y. Bailey, B. S.	Assistant Agronomist
D. G. Sturkie, Ph. D.	Assistant Agronomist
G. H. Jester, B. S.	Assistant in Agronomy
F. E. Bertram, B. S.	Assistant in Agronomy
E. L. Mayton, B. S.	Assistant in Agronomy
J. W. Richardson, B. S.	Assistant in Agronomy
J. R. Taylor, B. S.	Assistant in Agronomy
H. W. Bennett, B. S.	Graduate Assistant
Hoyt Sherard, B. S.	Graduate Assistant

Animal Husbandry, Dairying, and Poultry:

J. C. Grimes, M. S.	Head Animal Husbandry, Dairying, and Poultry
W. D. Salmon, M. A.	Research Professor Animal Nutrition
G. A. Shrader, Ph. D.	Associate Research Professor Animal Nutrition
C. O. Prickett, A. B.	Associate Research Professor Animal Nutrition
G. A. Trollope, B. S.	Poultry Husbandman
D. F. King, M. S.	Assistant Poultry Husbandman
W. E. Sewell, M. A.	Assistant Animal Husbandman
G. J. Cottier, M. A.	Assistant in Animal Husbandry
C. T. Bailey, B. S.	Superintendent Poultry Farm

Botany and Plant Pathology:

W. A. Gardner, Ph. D.	Botanist
J. L. Seal, Ph. D.	Associate Plant Pathologist
G. L. Fick, M. S.	Assistant Botanist

Entomology:

J. M. Robinson, M. A.	Entomologist
L. L. English, Ph. D.	Associate Entomologist
H. S. Swingle, M. S.	Associate Entomologist
*F. S. Arant, M. S.	Assistant Entomologist
W. C. Kelley, B. S.	Assistant in Entomology

*On leave.

**Assigned by the State Department of Agriculture and Industry.

Home Economics:

Edna R. Bishop, M. A. Associate Home Economist

Horticulture and Forestry:

C. L. Isbell, Ph. D. Horticulturist
L. M. Ware, M. S. Associate Horticulturist
O. C. Medlock, M. S. Assistant Horticulturist
R. W. Taylor, M. S. Assistant Horticulturist
P. L. Wright, B. S. Graduate Assistant

Special Investigations:

J. F. Duggar, M. S. Research Professor of Special Investigations

Veterinary Medicine:

M. W. Emmel, M. S. Animal Pathologist

Agricultural Substations:

Fred Stewart, B. S. Superintendent Tennessee Valley Substation,
Belle Mina, Ala.
C. F. King, Assistant to Superintendent Tennessee Valley Substation,
Belle Mina, Ala.
R. C. Christopher, B. S. Superintendent Sand Mountain Substation,
Crossville, Ala.
J. M. Henderson, B. S. Assistant to Superintendent Sand Mountain Substation,
Crossville, Ala.
J. P. Wilson, B. S. Superintendent Wiregrass Substation,
Headland, Ala.
K. G. Baker, B. S. Superintendent Black Belt Substation,
Marion Junction, Ala.
Otto Brown, M. S. Superintendent Gulf Coast Substation,
Fairhope, Ala.

CHANGES IN STATION STAFF DURING 1930-31

Appointments:

Anna L. Sommer, Ph. D. Associate Soil Chemist
F. L. Davis, M. A. Assistant Soil Chemist
F. E. Bertram, B. S. Assistant in Agronomy
Hoyt Sherard, B. S. Graduate Assistant
G. A. Schrader, Ph. D. Associate Research Professor Animal Nutrition
C. O. Prickett, A. B. Associate Research Professor Animal Nutrition
W. E. Sewell, M. A. Assistant Animal Husbandman
G. J. Cottier, M. A. Assistant in Animal Husbandry
Edna R. Bishop, M. A. Associate Home Economist
L. M. Ware, M. S. Associate Horticulturist
M. W. Emmell, M. S. Animal Pathologist

Resignations:

L. D. Baver, Ph. D. Associate Soil Chemist
W. W. Pate, M. S. Assistant Soil Chemist
W. D. Lucas, B. S. Assistant in Agronomy
J. A. Naftel, B. S. Assistant in Soils
C. J. Rehling, B. S. Assistant in Soils
N. B. Guerrant, Ph. D. Associate Research Professor of Animal Nutrition
E. V. Smith, B. S. Assistant in Botany
W. D. Kimbrough, Ph. D. Associate Horticulturist
E. E. McLean, M. A. Assistant in Agricultural Economics

NEW PUBLICATIONS

Bailey, R. Y., and Mayton, E. L.—**Kudzu in Alabama.** *Alabama Experiment Station Circular 57.* This circular reports the results of studies with kudzu relative to feeding value, yields of hay, effect of time and frequency of cutting, harvesting, soil improvement, cultural methods, soil and fertilizer requirements, and the probability of the plant becoming a pest. Kudzu produced large yields of hay on poor land without fertilizer; this crop will not stand frequent mowing or close grazing throughout the season.

Grimes, J. C., Sewell, W. E., and Taylor, W. C.—**Oats with Vetch or Austrian Peas as Grazing Crops for Fattening Hogs.** *Alabama Experiment Station Bulletin 233.* This bulletin reports results of four tests on the value of oats and vetch or oats and Austrian peas as grazing crops for fattening hogs. Results show

that hogs self-fed corn and tankage made faster and cheaper gains when allowed to graze oats and vetch or oats and Austrian peas than when similarly fed in the dry lot.

Grimes, J. C., and Nichols, M. L.—**The Trench Silo.** *Alabama Experiment Station Circular 59.* This circular reports studies of the trench silo with particular reference to the cost of construction, economy of filling, and keeping quality of the silage stored.

Grimes, J. C., Sewell, W. E., and Taylor, W. C.—**Grading up Hogs by the Use of Purebred Sires.** *Alabama Experiment Station Bulletin 234.* This bulletin reports results of studies to determine the value of purebred sires for improving the quality and type of native scrub hogs. Purebred boars were used through three successive generations. Improvement in type, quality, and ability to make rapid and cheap gains was noted in each successive generation.

Sturkie, D. G., and Bailey, R. Y.—**Experiments with Hay Crops in Alabama.** *Alabama Experiment Station Circular 58.* This circular reports the results of studies with various crops and fertilizer treatments for hay and makes recommendations for producing hay in Alabama.

Baver, L. D., and Scarseth, G. D.—**The Nature of Soil Acidity as Affected by the SiO_2 -Sesquioxide Ratio.** *Soil Sci.*, 31, 159-173. This paper reports the results of an investigation of the colloids from 21 soils representing various kinds of weathering. From the determinations of the SiO_2 -sesquioxide ratio, the total exchange capacity, and the characteristics of the soil acids in these colloids, it was found that in mature soils the characteristics of the soil acids are solely a function of the kind and extent of weathering and are independent of the kind of parent material. The relationship between the buffer capacity, total exchange capacity, and the degree of weathering of these soils is described.

Baver, L. D., and Scarseth, G. D.—**A Physico-Chemical Study of the Susquehanna Fine Sandy Loam Profile.** *American Soil Survey Association, Bul. XII*, 7-11. A study of the physico-chemical properties of the soil materials and colloids from the different horizons of the Susquehanna fine sandy loam profile shows that the soil acid of the parent material is much stronger than that in the weathered horizons, that Fe_2O_3 and Al_2O_3 have accumulated in the weathered horizons and SiO_2 has been removed, that the soil is immature, and that the lateritic type of weathering has been predominant.

Baver, L. D.—**The Atterberg Consistency Constants: Factors Affecting their Values and a New Concept of their Significance.** *Jour. Amer. Soc. Agron.*, 22, 935-948. This is a study of the factors affecting the Atterberg consistency constants. A theory is

advanced explaining the plasticity of soils as due to disc-shaped colloidal particles. The relation between the Atterberg consistency constants and soil dynamic properties is described.

Emmel, M. W.—**Spirochetosis Associated with Infectious Bronchitis.** (A case report). *Jour. Am. Vet. Med. Assoc.*, LXXVIII, (N. S.) 31, 710. An outbreak of infectious bronchitis in fowls is described in which spirochetes were associated with the usual lesions found in the trachea. The spirochete varied from 6 to 18 microns in length and from 0.4 to 0.6 microns in width. The spirals were rather gradual and numbered from 3 to 8, one spiral occurring in about every two microns of length. Efforts to transplant the spirochetes to the tracheal mucosa of healthy birds failed. It is assumed that the spirochete was playing the role of a secondary invader.

Isbell, C. L.—**Regeneration in Leaf Cuttings of Ipomoea Batatas.** *The Botanical Gazette*, XCI, 411-425. Results obtained from a study of seven different types of sweet potato leaf cuttings are reported.

Kimbrough, W. D.—**The Quality of Strawberries as Influenced by Rainfall, Soil Moisture, and Fertilizer Treatment.** *Amer. Soc. Hort. Sci.*, 27, 184-185. Results of analysis are given which show greater differences in composition of berries due to differences in soil moisture than to differences in fertilizer treatments.

Nichols, M. L.—**An Explanation of the Dynamic Properties of Soil.** *Jour. Am. Soc. Agric. Eng.* 12, 259-264. Data gathered in dynamics studies indicate that the reactions of the soils studied are due to the film moisture on the colloidal particles, and that the values for different reactions may be obtained from mathematical calculations from the colloidal content or from the Atterberg consistency constants.

Nichols, M. L.—**A Study of Soil and Metal Friction Properties.** *Jour. Am. Soc. Agric. Eng.* 12, 321-325. The general laws of soil and metal friction are set forth with mathematical formulas giving the frictional values of various types of soils.

Pierre, W. H., and Scarseth, G. D.—**Determination of the Percentage Base Saturation of Soils and Its Value in Different Soils at Different pH Values.** *Soil Sci.*, 31, 99-114. This study reports a comparison of the $\text{Ba}(\text{OH})_2\text{-NH}_4\text{Cl}$ and $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2\text{-NH}_4\text{Cl}$ methods for determining total exchange capacity as a basis for obtaining the percentage base saturation of different soils. The percentage base saturation of a number of soils of similar and different origins at like pH values is reported to vary considerably. This investigation includes a study of the influences of organic matter and the nature of the bases present in the exchange complex on the percentage base saturation of the soils at like pH values.

Pierre, W. H.—**Hydrogen-Ion Concentration, Aluminum Concentration in the Soil Solution, and Percentage Base Saturation as Factors Affecting Plant Growth on Acid Soils.** *Soil Sci.*, 31, 183-207. This investigation shows the hydrogen-ion concentration of different soils at which plant growth is definitely reduced and the concentration of aluminum in the displaced soil solution at various degrees of acidity and its effect on plant growth. It also shows the influence of the percentage base saturation of acid soils on plant growth.

Salmon, W. D., and Guerrant, N. B.—**Liver Extract as a Source of Vitamins B and G.** *Sci.* 73, 243-244. Liver extract (Lilly No. 343) contains four or five times as much vitamin G but only about one-fifth as much vitamin B as a high grade brewers' yeast.

Taylor, R. W.—**Influence of Winter Application of Fertilizers to Strawberries.** *Amer. Soc. Hort. Sci.*, 27, 187-189. Data are presented which show a significant increase in yield of strawberries from the addition of nitrogen in January to plants which had been variously fertilized the previous season; this increase was apparently due to the formation of new flower buds and not to a greater size of berry or to a better set of blooms.

Tidmore, J. W.—**Phosphate Studies in Solution Cultures.** *Soil Sci.*, 30, 13-31. Experiments are reported in which a study was made of the concentration of PO_4 required for the maximum growth of corn, sorghum, and tomatoes. In addition, the influence of the PO_4 concentration of the culture solution on PO_4 absorption, on rate of growth, on percentage of PO_4 in the dry tissue, on PO_4 content of the plant sap, and on the buffer capacity of the sap was studied.

AGRICULTURAL ECONOMICS

An Economic Study of Poultry and Cotton Farming in Marshall and DeKalb Counties, Alabama, 1927-1929. (C. G. Garman).—Eighty-eight farm business records of cotton farms having commercial poultry flocks, and 236 records of cotton farms having small farm flocks of poultry were obtained during the three years 1927-1929.

Farmers having commercial poultry flocks received an average return of \$.43 per hour for time spent on their laying flocks during the three years. The farmers having less than 100 layers had an average return of \$.28 per hour for time spent on their laying flocks and those having 200 or more layers had an average return of \$.53 per hour. Commercial flocks having an average annual production between 70 and 129 eggs per layer returned an average of \$.18 per hour of labor spent on the laying flock, and those having a production of 160 or more eggs per layer returned an average of \$.76 per hour.

The farmers having commercial poultry had an average labor income of \$313 for the three years, and the farmers having small farm flocks had an average labor income of \$253. This difference is due principally to the fact that when cotton prices had dropped to a level slightly above 15 cents per pound in 1929 the labor incomes of the farmers having commercial poultry averaged \$320 and the labor incomes of the farmers having farm flocks averaged \$36.

Some of the factors associated with labor incomes on these farms were receipts from poultry, receipts from work off the farm, acres of cotton, and yield of cotton per acre. Yield of cotton per acre was more closely associated with labor income than any other factor studied. Farms having a yield of less than 300 pounds of lint per acre had an average labor income of \$58 for the three years, and farms having a yield of 400 or more pounds of lint per acre had an average labor income of \$653.

Fields of cotton on these farms that had less than 450 pounds of fertilizer applied per acre, costing an average of \$6.14, had an average yield of 291 pounds of lint. The fields that had 600 or more pounds of fertilizer applied, costing an average of \$10.43, had an average yield of 395 pounds of lint per acre.

The farmers who used two-horse cultivators had a higher average labor income than those who used one-horse implements. The farmers who used two-horse cultivators spent 17 man hours less labor per acre in the pre-harvest operations on cotton than those who used one-horse implements.

A Study of Farm Organization on the Heavy Clay Soils of the Black Belt of Alabama. (J. D. Pope and C. M. Clark).—In three areas selected to represent the Black Belt of Alabama, 320 farm business records were obtained for the crop year of 1929. Cotton, the principal type of farming, included 78 per cent of the total farms but these farms comprised only 34 per cent of the total acreage. Only five farms out of 251 cotton farms were

TABLE 1.—Average Acreage per Farm, Color of Operator, and Labor Income by Type of Farm in Three Areas of the Black Belt of Alabama, 1929

Type of farm operated	Farms		Average acreage per farm	Color of operator		Average labor income	
	Number	Per cent		White	Colored	Excluding outside receipts	Including outside receipts
Cotton	251	78.4	45	5	246	\$ -12	\$ 33
Dairy	24	7.5	326	18	6	686	884
Beef	10	3.1	510	10	-	-632	951
Hay	5	1.6	242	3	2	385	987
Mixed	30	9.4	279	15	15	-118	43
All farms	320	100.0	106	51	269	\$ 17	\$141

operated by white farmers. White farmers operated dairy, beef and hay farms or a combination of these types.

One-fourth of all land was in cultivated crops and 8 per cent of the tillable land was idle. Fourteen per cent was in Johnson grass hay and 38 per cent in pasture. Cotton acreage comprised about 32 per cent, corn 24 per cent, and hay 36 per cent, a total of 92 per cent of all crop land.

Average net cost per pound of lint on all farms reporting cotton produced was 12.2 cents. The average profit was 4.8 cents per pound of lint. An average loss of 7.6 cents per pound of lint was made by 64 farms in Montgomery County whereas a profit of 5.5 cents per pound of lint was made by 108 farmers in Perry County and 6.5 cents by 90 farmers in Greene County. Average cost of lint per acre increased from \$13.64 for fields yielding 50 pounds or less of lint per acre to \$17.31 for fields yielding 200 pounds or more per acre while the cost per pound of lint decreased from 44 cents to 7 cents. The average return per hour of labor increased from minus one cent per hour to 30 cents per hour.

Four-fifths of all operators were tenants and 95 per cent of all tenants were colored. Seventy-five per cent of the white farmers owned part or all of the land they operated as compared to 9 per cent for colored farmers. The highest labor income for any tenure group was \$512 made by absentee owner operators. Cash renters made the largest labor income in the tenant group averaging \$71. Share renters made the lowest labor income of all tenure groups averaging —\$233. Average return on investment of 69 absentee landlords was 3 per cent. Thirteen per cent of the absentee landlords made a minus return on investment. Landlords have valued their property nearly twice the capitalization of net returns at 6 per cent.

A Study of the Organization of Farms in the Peanut Area of Alabama. (J. D. Pope).—The average farm incomes in this area in 1927 and 1928 increased as the size of the farms increased. The farms having the largest acreage in peanuts had a larger portion of Spanish type peanuts, a smaller per cent of their peanut acreage hogged off, and a smaller portion of their gross income from hogs than those having only a small acreage in peanuts.

Approximately one-third of the corn acreage on these farms was interplanted with peanuts. When the interplanted acres were converted to equivalent solid acres, the yield of corn was higher for the acreage interplanted than for the acreage planted solid but there was very little difference in the average yield of peanuts.

The average yield of corn per acre was more than five bushels higher on the farms having 250 or more pounds of fertilizer applied per acre than on the farms having 0-49 pounds of fertilizer applied.

AGRICULTURAL ENGINEERING

Experiments with Machinery for Planting Oats. (E. G. Diseker).—Land was prepared and oats were planted by different methods. The following combinations of equipment were used: (1) endgate seeder, two-mule wagon, 8-foot wheatland plow and 15-30 tractor; (2) 8-foot tandem disc, 6-foot drill, 15-30 tractor; (3) 8-foot wheatland plow, 15-30 tractor, 6-foot tandem disc, 6-foot drill, 10-20 Farmall; (4) 2-bottom plow, 15-30 tractor, 6-foot drill, 10-20 Farmall. Combination (1) was the most economical of fuel and labor costs and the yield of oats was as good with this method as with any of the other methods tried.

Weed Control Studies. (E. G. Diseker).—Tests of the rotary hoe for the cultivation of young corn and cotton during a favorable season showed this to be a profitable implement on both black belt and sandy soil. The cost of cultivating and hoeing was greatly reduced by using this implement. It also was found to be a desirable implement for the precultivation of sandy soil, just before planting.

A one horse spring tooth weeder was used to break crusts on cotton just coming up and to cultivate young corn and cotton on various soil types. This implement greatly aided in getting up a stand of cotton and gave a light cultivation for the young crops in the row and middles. It was found that one mule and man could cover 20 acres per day with this machine.

Soil Dynamics. (M. L. Nichols).—A review of all data gathered to date was made to determine the fundamental causes of soil's physical reactions. All evidence indicated that the film moisture on the colloidal particles dominated and practically determined all of these reactions.

Further studies of friction between soil and various plow metals resulted in the determination of a mathematical formula from which friction values may be determined from the colloidal content of non plastic soils and from the Atterberg consistency constants of plastic soils. The abrasive power of soils depends upon the sand content, other soil properties apparently exerting little or no effect.

It was found that the injurious puddling effect of pressure varies with the colloid content of a soil and that a sliding motion of the surface applying force resulted in greater puddling injury than when the pressure was applied directly.

Laboratory studies were made of the draft of implements in various soils and it was found that:

- (1) Pull or draft was proportional to the depth at which the implement ran in the soil.
- (2) This value depended upon the shear value of the soil, the laws of which have already been published in a previous report.

TABLE 2.—The Pounds of Soil Eroded per Acre when One Inch of Rain Was Applied on Saturated Soil with Vetch as Compared with No Crop

Percent- age slope	0		5		10		15		20	
	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour
With vetch	63.10	94.36	80.49	65.11	90.36	82.19	569.04	268.80	604.36	284.61
No crop	457.62	190.99	1093.30	193.72	1515.54	238.84	6733.22	2393.08	9256.22	5823.20

TABLE 3.—Pounds of Soil Eroded per Acre on Plowed and Unplowed Soil having Rows Running with and across the Slope when One Inch of Rain was Applied on Saturated Soil

Percent- age slope	0		5		10		15		20	
	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour	Rows with slope	Rows con- tour	Rows con- tour	Rows with slope	Rows con- tour	Rows con- tour
Land not plowed	457.62	190.99	1093.72	193.72	1515.54	238.84	6733.22	2393.08	9256.22	5823.20
Land plowed	610.16	623.50	2123.96	1995.20	2315.94	2427.88	9512.16	6294.16	19301.24	19000.80

- (3) The pull was proportional to the apparent specific gravity of the soil.
- (4) The effect of the slope of the surface of the tillage implement was governed by the general laws of the inclined plane.

Soil Erosion. (M. L. Nichols and Hugh Sexton).—The field equipment for the study of erosion was completed and methods of studying the factors involved were further developed. The tentative conclusions derived from this year's study follow.

The relation of rainfall to runoff and amount of material eroded is governed by the following factors: (1) amount of rainfall, (2) rate of rainfall, (3) moisture content of soil before rains, (4) soil structure or state of pulverization, (5) surface protection and, (6) surface shape.

Results seem to indicate that the critical velocity of the water upon the soil (Cecil clay) in this study is reached on grades between 10 and 15 per cent. The relation of surface protection to erosion is shown by Table 2.

The relation of soil structure, or openness of the soil, to erosion is shown in Table 3.

AGRONOMY AND SOILS

Rotation Experiments. (R. Y. Bailey).—The Old Rotation experiment, which was started in 1896, includes plots that have been cropped continuously to cotton or corn with and without legumes, a two-year rotation of cotton and corn with legumes, and a three-year rotation of cotton, corn, and oats with legumes. Each plot in the experiment has been fertilized uniformly with phosphate and potash. No nitrogenous fertilizer has been applied since the beginning of the experiment.

Average yields for the eleven-year period, 1920-1930, inclusive, show that Plot 1, which was cropped continuously to corn with legumes, produced 11.4 bushels of corn per acre more than Plot 2, which was cropped continuously to corn without legumes. Where legumes were used in the cropping system the average yields of corn from continuous cropping, two-year rotation of cotton and corn, and three-year rotation of cotton, corn and oats were 19.7, 19.5, and 19.4 bushels per acre, respectively. In a continuous cropping system the average yield of seed cotton was increased 411 pounds per acre by the use of legumes. The average yields of seed cotton were 794, 899, and 771 pounds per acre, respectively, for continuous cropping, for a two-year rotation, and for a three-year rotation; legumes were grown in each cropping system. There was no crop in 1925 due to drought and the yields include only 10 crops for the 11-year average.

A three-year rotation of cotton, oats, and corn, known as the Cullars Rotation, was started in 1911 to study the comparative values of rock phosphate and superphosphate. Cowpeas were

planted broadcast after oats and in the corn middles at the last cultivation. The cowpeas were disked down and followed by winter legumes, which were turned for the next crop.

Average yields of nine crops harvested from 1921 to 1930, inclusive, show that the plot on which superphosphate was used made 1,065 pounds of seed cotton per acre while the plot which received rock phosphate made 989 pounds per acre. There was practically no difference between the yields of corn and oats produced by superphosphate and rock phosphate. Superphosphate was applied for cotton at the rate of 544 and rock phosphate at the rate of 1,088 pounds per acre. Half of the above rates was used for corn. Both plots received the same amount of nitrate of soda and muriate of potash. Two other plots were treated with nitrate of soda and muriate of potash; one plot received 544 pounds of superphosphate per acre, whereas no phosphate was used on the other. The plot on which superphosphate was used made an average yield of 1,065 pounds of seed cotton per acre during the last nine years and the other plot made 485 pounds.

Two other plots, A and B, were started in 1914 to study the effect of legumes in the cropping system. Each plot received 480 pounds of superphosphate and 100 pounds of muriate of potash per acre in the rotation. Plot A had legumes turned under while Plot B had no legumes. Plot A made an average yield of 594 pounds of seed cotton and 33.1 bushels of corn per acre during the last nine years, whereas Plot B made 116 pounds of seed cotton and 8.2 bushels of corn. The differences in yields were due to the effect of legumes in the cropping system.

Methods of Planting Oats. (R. Y. Bailey).—During the four-year period of 1928 to 1931, different methods of seeding oats were studied. Oats were sown broadcast and disked-in on broken and on unbroken land and were drilled in cotton middles on unbroken land on October 15 and November 15. The results of this experiment are shown in Table 4.

TABLE 4.—Yields of Oats in Methods of Seeding Experiment*

Plot No.	Method of seeding	Date of seeding	Bushels of oats per acre
			4-Year average 1928-1931
1	Land turned. Oats broadcast and disked-in.	Oct. 15	39.6
2	Land not broken. Oats broadcast and disked-in.	" "	34.0
3	Land not broken. Oats drilled.	" "	33.1
4	Land turned. Oats broadcast and disked-in.	Nov. 15	31.0
5	Land not broken. Oats broadcast and disked-in.	" "	28.7
6	Land not broken. Oats drilled.	" "	24.7

*Each plot was fertilized with 200 pounds of nitrate of soda per acre the last of February.

The results in Table 4 show that the plot which was turned made six bushels per acre more than the plot which was drilled in cotton middles. Oats planted October 15 without preparation made more than those planted one month later on well prepared land.

A Comparison of Nitrate of Soda and Ammonium Sulfate for Cotton. (R. Y. Bailey).—Nitrate of soda and ammonium sulfate for cotton were compared on limed and unlimed land during the six-year period, 1925-1930, inclusive. The details of the experiment and the average yields are shown in Table 5.

TABLE 5.—Yields of Seed Cotton per Acre on Limed and Unlimed Land Fertilized with Nitrate of Soda or Ammonium Sulfate

Plot No.	Pounds fertilizer per acre*	Yields of seed cotton	
		Six-year average 1925-1930	
		Limed	Unlimed
		Pounds	Pounds
1	400 Nitrate of soda	1,142**	1,089
2	300 Ammonium sulfate	1,214	854
3	None	778	708
4	200 Nitrate of soda	1,087	1,007
5	150 Ammonium sulfate	1,087	893

*Each plot received 800 pounds of superphosphate and 200 pounds of muriate of potash per acre annually.

**The limed section of Plot 1 was injured by erosion, which reduced the average yield.

The two sources of nitrogen produced practically the same amount of cotton on limed land. However, on unlimed land nitrate of soda made 235 pounds of seed cotton per acre more than ammonium sulfate when used at the heavier rate and 114 pounds more when the lighter rate was used.

The Influence of Rate of Fertilization on the Yields of Different Mixtures of Pasture Plants. (E. L. Mayton).—Bur, White, and Ladino clovers and Black Medic were seeded on an area in the fall of 1925. In the spring of 1926 this area was divided into sections and different grasses or mixtures of grasses were seeded on each section. One section was seeded to Dallis grass, one to Carpet grass, one to Bermuda grass, and a fourth to a mixture of the three grasses. Lespedeza was seeded along with the grass seeding on each section, and in the fall of 1926 Carolina and Hop clovers were seeded on each section.

Each section was divided into plots for fertilizer treatments, the same treatment being in duplicate on each section. The fertilizer treatments varied from the basic rate of N P K to include a high mineral and low nitrogen plus lime fertilizer; a high nitrogen and low mineral fertilizer; and the basic rate plus lime. The basic rate designated as N P K was 200 pounds of nitrate of soda, 600 pounds of superphosphate, and 150 pounds of muriate of potash. The nitrogen fertilizer only was applied annually, other fertilizers being applied every five or six years.

Beginning in 1927 these plots were harvested with a lawn mower with basket attachment as often as there was sufficient growth.

The four year's results may be summarized as follows:

- (1) The only plants which have withstood the conditions of this experiment are Hop clover in the early spring and the three grasses and lespedeza in the summer.
- (2) The high nitrogen and low mineral fertilizer gave the largest increase over checks on all sections; all treatments gave a relatively small increase in yield over the check plots. Plots fertilized with a complete fertilizer plus lime had a better balanced sod with respect to clovers and grasses than those plots which received only a complete fertilizer.
- (3) The highest yields on like fertilized plots were obtained on those plots where Dallis grass was used in the mixture. Dallis grass has stood dry weather conditions in the summer better than either Carpet grass or Bermuda grass. Lespedeza has grown well in a mixture with Dallis grass and Bermuda grass but is somewhat crowded by Carpet grass.

Ammonium Sulfate and Sodium Nitrate Compared with Sodium Nitrate Alone for Cotton. (J. T. Williamson).—The use of one-fourth of the nitrogen in the form of ammonium sulfate at planting time and the remaining three-fourths as sodium nitrate at the time of the first cultivation gave higher yields than the use of one-fourth of the nitrogen as sodium nitrate at planting time and the remainder in the same form at the time of the first cultivation. The average results from 59 tests conducted in 1929 and 1930 show that ammonium sulfate-sodium nitrate plots produced 954 pounds of seed cotton per acre as compared with 923 pounds on the sodium nitrate plots. Each plot received a total application of 30 pounds of nitrogen, 64 of phosphoric acid, and 25 of potash per acre.

Basic Slag vs. Superphosphate for Cotton. (J. T. Williamson).—The average results from 109 cooperative experiments conducted over a period of five years show that 400 pounds of 16 per cent superphosphate produced an average increase of 167 pounds of seed cotton per acre as compared with an increase of 99 pounds from 600 pounds of low grade basic slag (approximately 10½ per cent) when both were used as direct applications to cotton with 200 pounds of nitrate of soda and 50 pounds of muriate of potash. Basic slag gave a greater yield than superphosphate on only one (Oktibbeha) of the eight soil groups on which the two sources of phosphorus were compared.

The above results are in sharp contrast with the results secured with these two sources of phosphorus when they were compared in rotations carrying legumes. When used in the rotations, basic slag was as effective as superphosphate when the

two materials were used on unlimed soils. (See Forty-First Annual Report, Alabama Experiment Station.)

Cotton Variety Tests. (H. B. Tisdale).—Nine non-wilt resistant and eight wilt resistant variety tests of cotton were conducted in as many different localities of Alabama in 1930. The results of these tests are shown in Tables 6 and 7.

TABLE 6.—Length of Staple and Yield of the Five Highest Yielding Varieties of Cotton in North and Central Alabama

North Alabama Average 17 tests, 1926-1930			Central Alabama Average 12 tests, 1926-1930		
Variety	Yield of lint in pounds per acre	Length of staple in 1/32 inches	Variety	Yield of lint in pounds per acre	Length of staple in 1/32 inches
Cook 1010	368	26.7	D.P.L. 4-8	431	31.1
D. P. L. 4-8	361	30.9	Cook 1627	422	28.5
Cook 1627	352	29.0	Dixie-Triumph (Watson)	422	28.3
Trice	349	31.3	Cook 588	419	27.7
Delfos	348	33.7	Cook 307 (Rhyne)	415	28.0

TABLE 7.—Length of Staple and Yield of the Five Highest Yielding Varieties of Cotton in the Black Belt and Wilt Infested Sections of Alabama

Black Belt Section Average 3 tests, 1926-'27-'30			Wilt Infested Section Average 25 tests, 1926-30		
Variety	Yield in pounds lint per acre	Length of staple in 1/32 inches	Variety	Yield in pounds lint per acre	Length of staple in 1/32 inches
Cleveland-Piedmont	317	28.7	Cook 307 (Rhyne)	391	27.6
Cook 1010	308	28.0	Dixie-Triumph (Watson)	387	28.0
Dixie-Triumph (Watson)	308	30.0	Toole (Council)	384	28.1
D.P.L. 4-8	295	31.3	Cook 307 (Bridges)	367	27.1
Cook 588	293	28.0	Lewis 63	364	28.2

Corn Variety Tests. (H. B. Tisdale).—Nine variety tests of corn were conducted in as many different localities of Alabama in 1930. Table 8 shows the five highest yielding varieties with the yield in bushels of grain per acre for each section of the state.

The results of two years testing of yellow varieties of corn show that Locker's Yellow, Graves' Yellow, and Indian Chief are promising varieties of yellow corn for Alabama.

TABLE 8.—Average Yield of Corn per Acre for Three Sections of the State, 1926-1930

North Alabama Average 12 tests		Central Alabama Average 7 tests		South Alabama Average 5 tests	
Variety	Yield bushels	Variety	Yield bushels	Variety	Yield bushels
Hastings	27.7	Whatley		Whatley (What-	
Douthit	26.9	(Hudson)	25.7	ley Bros.)	27.0
Whatley		Douthit	25.4	Douthit	25.1
(Whatley		Whatley (What-		Mosby (Delta)	23.5
Bros.)	25.8	ley Bros.)	24.7	Pee Dee No. 5	22.3
Mosby (Delta)	25.6	Hastings	23.5	Hastings	22.1
Neal's Pay-		Mosby (Delta)	23.0		
master	25.4				

A Study of Some Factors Affecting Lint Development of Cotton. (D. G. Sturkie).—During the past three years a study of the influence of temperature, evaporation, humidity, soil moisture, and soil type on lint development of cotton has been made. Cotton grown in soil from the Mississippi Delta and that grown in Norfolk sand under optimum moisture conditions produced bolls of the same size and lint of the same length.

The relationship between soil moisture and length of lint is very definite; the amount of soil moisture present from one to fifteen days after blooming affected the length of lint produced by the boll. Short lint was associated with a low moisture content at that time. The size of the boll was reduced by a low soil-moisture content.

The Influence of Nitrate of Soda on the Yield and Composition of Sudan Grass Hay. (D. G. Sturkie).—Studies of the effect of rate and time of applying nitrate of soda on yields and protein content of Sudan grass have been made during the five-year period, 1926 to 1930. The following sodium nitrate treatments were used: 0, 100, 200, 400, and 600 pounds per acre; in some cases the entire amount was added at one application and in others it was divided into two applications. The yield and protein content of the hay were increased by nitrate of soda. The most profitable application was 100-200 pounds per acre applied as soon as the grass was up.

The Time of Cutting Sudan and Johnson Grass for Hay. (D. G. Sturkie).—In a study of the time of cutting Sudan and Johnson grass for hay three stages were compared: viz; booting, blooming, and late milk stages. The largest yield of Johnson grass and the largest amount of total nutrients were produced when it was cut either in the blooming or in the late milk stage. There was little if any difference in favor of either of these two stages. Sudan grass produced the largest yield when cut in the late milk stage.

Plant Introduction Studies. (D. G. Sturkie).—Several species of crotalaria made excellent growth and may be of value for soil improvement in this state. *Crotalaria spectabilis* was the largest producer of seed. This species yielded at the rate of 1,650 pounds of seed per acre. About 60 per cent of the viable seed were hard and required scarification before they germinated.

The Nature of Soil Buffer Action. (L. D. Bayer).—The total buffer capacity of soils can be determined from the titration curves of the soils by use of the equation:

$$\text{Total buffer capacity} = \sum \frac{\Delta B}{\Delta \text{pH}} = \sum \pi \left[\begin{array}{l} \text{pH with no exchangeable} \\ \text{hydrogen present} \\ \text{pH of original soil} \end{array} \right]$$

Where ΔB equals one milli-equivalent base per 100 grams of soil, and ΔpH equals unit changes in the pH value. This equation gives the buffering at various pH values as well as the total buffer capacity.

Sub-Tropical Weathering of Soils in Alabama. (L. D. Bayer and G. D. Scarseth).—A thorough study was made of the physical and chemical properties and composition of the soil and colloidal material from different horizons in the Susquehanna fine sandy loam profile. It was found that weathering of this profile has been retarded probably due to the extreme acidity and impermeable nature of the parent material. The high acidity resulted from a low content of Na and K, and consequently low OH ion concentration, and the impermeability retarded soil solution movement; both are conditions favorable to the retardation of weathering.

Lateritic type of weathering has been predominant in the development of this profile as shown by a loss of SiO_2 and an accumulation of Al_2O_3 and Fe_2O_3 in the weathered horizons; soils adjacent but north of the location of the Susquehanna profile show by their low SiO_2 - Al_2O_3 ratios of 1.4 to 2.3 distinct lateritic effects; and the leaching of the K_2O and Na_2O from the profile is of the same order of magnitude as soils weathered under lateritic influences.

On the basis of the data in this study the upper limit of the effect of the lateritic type of weathering is placed at the 61°F . mean annual temperature line. This places most of the soils of Alabama under the influence of laterization.

Available Phosphorus and Greenhouse Pot Tests. (G. D. Scarseth).—There was no definite correlation found between P_2O_5 content of soil determined by electrodialysis and the plant-growth in greenhouse pot tests.

A high degree of correlation (.884) was found to exist between the P_2O_5 obtained by the Truog .002N H_2SO_4 extraction method and the growth made by oats in greenhouse pot tests on

Black Belt soil types, where nitrogen and potassium were applied as fertilizers and phosphorus was omitted. It was found from the 22 soils used in this correlation that 30 pounds of P_2O_5 per two million pounds of soil by the Truog method was sufficient to produce only about one-fourth normal growth of oats, 60 pounds of P_2O_5 produced approximately one-half normal growth, and the one soil having over 100 pounds of P_2O_5 produced a normal growth without phosphorus fertilization.

The Rate and Degree of Fixation of Superphosphate by Black Belt Soils. (G. D. Scarseth).—A greenhouse pot experiment was conducted with Sumter, Eutaw, and Perry clays with various applications of superphosphate without or with calcium carbonate applied at various periods before planting oats. This test showed that a 250 pound application of superphosphate per acre without calcium carbonate was practically lost to the plants when applied 365 days before planting. Calcium carbonate applied at planting decreased the oat yield on cultures receiving a 250 pound application of superphosphate but slightly increased the yield on cultures receiving 2,000 pounds of superphosphate. Calcium carbonate applied one year before planting greatly increased the yields with all rates of superphosphate used. The Sumter clay, being alkaline, received no lime treatment.

As the results with phosphorus were similar on all the soils and lime gave similar results on the acid soils, Table 9 is shown in order to bring out typical results.

TABLE 9.—The Effect of Different Rates and Periods of Application of Superphosphate with Calcium Carbonate Applied at Different Intervals Before Planting, and without Calcium Carbonate on the Yield of Oats on Perry Clay, No. 762

Superphosphate pounds per acre	No lime				Number of days limed* before planting			
					365	180	0	365
	Number of days superphosphate was applied before planting							
	365	180	30	0	0	0	0	365
	gms.	gms.	gms.	gms.	gms.	gms.	gms.	gms.
250	2.1	3.8	15.8	16.8	6.9	5.3	4.0	2.4
500	4.9	10.3	26.3	27.7	25.9	23.1	12.7	5.6
1000	11.5	19.8	38.9	40.7	53.0	33.8	29.9	22.2
2000	24.6	41.8	46.7	47.5	62.9	57.5	51.0	47.1

*11,474 pounds per acre to bring soil to pH 6.5.

Buffer Action and Exchangeable Ions in Black Belt Soils. (G. D. Scarseth).—The buffer curves from fourteen acidic Black Belt soils show that the soil acids within each soil type tend to be similar. This confirms our investigations on the nature of soil acidity that for each stage of weathering the soil acids are similar in their characteristics. The average buffer capacity ac-

cording to Bayer's equation for 8 soils with a common geological origin were: Lufkin clay, 676.6; Eutaw clay, 357.4; and Oktibbeha clay, 152.5. Previous investigations with these soils have established that the Lufkin clay is the most highly unweathered and the Oktibbeha clay the most highly weathered. The above buffer values indicate that the buffer power of soils is reduced by weathering.

The Lufkin, Eutaw, and Oktibbeha clays had an average total base exchange capacity of 35.0, 23.4, and 17.7 m.e. per 100 grams of soil, respectively. These values are of the same order of magnitude as the buffer capacities of these three soil types. The Lufkin, Eutaw, and Oktibbeha clays had an average base saturation of 34.0, 43.3, and 52.8 per cent, respectively. Two Houston clay soils were 97 and 100 per cent saturated with bases and one Leaf clay was 28.0 per cent saturated with bases. The total anion exchange capacity for the fourteen soils tested ranged from 0.37 to 1.75 m.e. per 100 grams of soil.

Phosphate Studies in Solution Cultures. (A. L. Sommer).—Wheat, peas, cotton, and tomatoes were placed in solutions with PO_4 concentrations maintained at 0.05, 0.2, 0.8, and 3.2 p.p.m. Solutions with a PO_4 concentration of 0.05 p.p.m. gave very poor growth in all cases. There was very marked improvement in growth at 0.2 p.p.m. for all plants excepting cotton. The improvement in growth at 0.2 p.p.m. seemed to be proportional to the extent of the root systems. Peas and tomatoes made what might be considered satisfactory growth at 0.2 p.p.m. but grew much better at higher concentrations. There was probably no significant difference in the growth of wheat at 0.2 p.p.m. as compared with that at higher concentrations. The total dry weight was greatest for the wheat plants grown in solutions with a PO_4 concentration of 0.2 p.p.m. but when the weight of the seeds was subtracted the plants grown in solutions with a PO_4 concentration of 3.2 p.p.m. weighed more. This was probably due to the fact that the plants at 0.2 p.p.m. matured a little earlier than those at higher concentrations and since all plants were badly infested with aphids at the time of heading, those which were farther advanced were able to produce more grain. The work is being continued.

Evidence of Organic Phosphorus Compounds in the Soil Solution. (A. L. Sommer).—Dialyzed soil extracts were examined by the magneto-optic method (J. A. C. S. 52, 3796, 1930) for PO_4 concentrations. Aliquots were treated with the following: H_2O_2 , HCl , takadiastase, and emulsin and were examined after being allowed to stand in contact with these reagents. The results are shown in Table 10. All reagents gave negative tests for PO_4 .

TABLE 10.—Inorganic Phosphate Concentration in Soil Extract Before and After Treatments Indicated

Soil No.	P ⁰⁴ concentration				
	Original	After H ₂ O ₂	After HCl	After takadiastase	After emulsin
1	.075x10 ⁻⁶	.1x10 ⁻⁶	.15x10 ⁻⁶	3.7x10 ⁻⁶	3.7x10 ⁻⁶
2	.3x10 ⁻⁶		1.5x10 ⁻⁶	.75x10 ⁻⁶	1.0x10 ⁻⁶
3	Between 1x10 ⁻⁸		No	Between 1.0x10 ⁻⁶	Between 1.0x10 ⁻⁶
	and 1x10 ⁻⁷		increase	and 1.0x10 ⁻⁵	and 1.0x10 ⁻⁵

ANIMAL HUSBANDRY, DAIRYING, AND POULTRY

Fattening Steers on Grass. (J. C. Grimes).—It was previously shown (*Bul.* 231) that it is profitable to feed cottonseed meal to steers that are being fattened on grass for the June market.

In order to determine whether it is more profitable to feed meal to steers on grass and market in June or allow the steers to run on pasture alone and market in the fall, two lots of steers were fed and managed as follows during the summer of 1930.

Lot A.—Good Black Belt pasture plus an average of 5.33 pounds of meal daily per head. Steers sold in June.

Lot B.—Good Black Belt pasture with no supplement. Steers sold in September.

The initial weight of the steers in Lot A was 564 pounds each. They were on pasture 77 days during which time they consumed a total of 411 pounds of cottonseed meal per steer and gained a total of 202 pounds per head. The feed and pasture cost for each hundred weight gain was \$4.12 and the selling price was \$8.25 per hundred pounds.

The initial weight of steers in Lot B was 556 pounds each. They were on pasture 168 days and gained 288 pounds per steer at a cost of \$1.04 per hundred weight gain. They sold for \$7 per hundred pounds.

With the price of cottonseed meal, pasture, and cattle which prevailed during this trial it was slightly more profitable to use pasture alone and sell the cattle in September than to feed cottonseed meal and sell in June.

The experiment is being continued, however, and the above results should not be considered final.

Soybean Hay as a Supplement to White Corn and Tankage for Growing and Fattening Hogs. (J. C. Grimes and W. E. Sewell).—Four trials have been conducted to determine the value of soybean hay as a supplement to white corn and tankage for growing and fattening hogs in the dry lot. Each trial contained three groups of pigs which were self-fed as follows: Group I, white corn 9 parts and tankage 1 part; Group 2, yellow corn 9 parts and tankage 1 part; Group 3, white corn 9 parts,

tankage 1 part, and soybean hay fed in rack. Each group received a mineral mixture of charcoal, lime, and salt, equal parts by weight.

A summary of the four trials shows that Group 3, which received soybean hay in addition to white corn and tankage, excelled Group 1, which received only white corn and tankage, in both rate and economy of gains, but Group 2, which received yellow corn and tankage, made cheaper and faster gains than either of the other groups. The average daily gain in Group 1 was 1.24 pounds, Group 2, 1.46 pounds; Group 3, 1.38 pounds. The concentrates required per 100 pounds gain were: Group 1, 400.15 pounds; Group 2, 372.92 pounds, and Group 3, 378.89 pounds.

For each 100 pounds of gain made the hogs in Group 3 consumed 19.82 pounds of soybean hay. This amount of hay saved 21.26 pounds of concentrates.

White Corn and Various Protein Supplements for Fattening Hogs in the Dry Lot. (J. C. Grimes, W. E. Sewell, and G. J. Cottier).—An experiment was started in January 1931 to determine the value of certain protein supplements which are commonly used in Alabama when fed in conjunction with white corn to fattening hogs in the dry lot. Four groups of ten hogs each were used. All groups received a basal ration of white corn and minerals self-fed. In addition each group received a protein supplement self-fed. The supplements used in the different lots were as follows: Lot I, 60 per cent digester tankage; Lot II, 40 per cent tankage; Lot III, 40 per cent commercial supplement; Lot IV, "Alabama trinity" composed of 60 per cent digester tankage 2 parts, cottonseed meal 1 part, and kudzu meal 1 part, by weight.

The average daily gains were: Lot I, 1.61 pounds; Lot II, 0.77 pounds; Lot III, 1.36 pounds; Lot IV, 1.66 pounds. The concentrates required per 100 pounds gain were: Lot I, 350.31 pounds; Lot II, 486.79 pounds; Lot III, 398.49 pounds; Lot IV, 345.46 pounds. From the above figures it will be seen that in both rate of gain and feed required per unit of gain, the "Alabama trinity" mixture ranked first, the 60 per cent digester tankage second, the commercial mixture third, and the 40 per cent tankage fourth.

Wintering Stocker Calves and Yearlings and Two-Year-Old Stocker Heifers. (J. C. Grimes).—Records were secured on the feed cost of wintering 93 head of Hereford calves, 50 head of long yearling Hereford heifers, and 72 head of two-year-old Hereford heifers. The calves were fed mixed alfalfa and Johnson grass hay, corn-cob-shuck meal, and cottonseed meal. The yearling and two-year-old heifers were fed Johnson grass hay and cottonseed meal. All animals had the run of a good permanent pasture.

The calves received 1.33 pounds of concentrates and 4.34 pounds of hay per head daily for 155 days. They gained 24.73 pounds per head during the winter and the feed cost of wintering was \$7.97 per head.

The yearling heifers received very little feed other than what they gleaned from the pastures and hay fields. They had the run of an excellent pasture and a Johnson grass hay field where the last cutting of hay the previous fall had been stacked in the field. They grazed in the pasture and ate from the hay stacks during most of the winter. When the hay stacks were consumed the yearling heifers were fed meal and hay from March 22 to April 8, a period of 18 days.

The two-year-old heifers were fed from January 6 to April 9. They received an average of 1.64 pounds of cottonseed meal and 4.19 pounds of Johnson grass hay per head daily in addition to pasture. They gained an average of 22.93 pounds per head during the winter and the feed cost of wintering was \$3.20 per animal.

Feeding Grain to Lambs for the Spring Market. (J. C. Grimes).—The experiment to determine the value of feeding grain to lambs that were being finished for the spring market was continued. One hundred seventy-six grade Southdown and Hampshire lambs were divided into two equal lots and fed as follows:

Lot I.—Grain mixture consisting of 75 pounds corn meal, 12 pounds wheat bran, 12 pounds cottonseed meal and one pound salt plus pasture and mother's milk.

Lot II.—Pasture and mother's milk but no grain.

The returns per lamb above feed and marketing cost was \$4.67 in Lot I, and \$4.50 in Lot II. No charge was made for pasture or labor.

Docking and Castrating Lambs. (J. C. Grimes).—During the spring of 1930 an experiment was conducted to determine the value of docking and castrating lambs. Eighty-six lambs were docked and castrated and the results compared with 90 lambs of similar age, quality, and breeding which were undocked and uncastrated. The results show that the average price per lamb received for docked and castrated lambs was \$5.67 and for undocked and uncastrated lambs \$5.47.

Mineral Supplements in the Dairy Ration. (W. H. Eaton).—This work is being studied with two objects:

- (1) Effect of mineral supplements on milk and fat production.
- (2) Effect of mineral supplements in dam's ration on size and weight of offspring.

All cows in the college herd are fed as nearly alike as conditions permit with the exception of mineral supplements. Group

1 cows are a check lot with no mineral. Group II cows in addition to regular ration are fed four ounces of bone meal daily. Group III in addition to the regular ration are fed four ounces of marble dust daily.

No noticeable effect has been noted on the milk and fat production of the mature cows under this test but to date 27 of their daughters have completed their first lactation periods and have been fed minerals identical with their dams. The mineral supplements have had no apparent effects on milk production or on size and weight of the offspring.

Fly Spray for Dairy Cows. (W. H. Eaton).—At the beginning of the fly season in 1929 and 1930 the milking herd was divided into equal lots; one row of cows being sprayed with a commercial fly spray mixture for two weeks, then the opposite line of cows was sprayed for a similar period. A preliminary period of one week was used in all tests and the milk records during these preliminary weeks discarded.

Covering an average test period of 168 cow weeks when measured in terms of milk yield the non-sprayed cows gave 2.79 lbs. of milk more per week than those on which the spray was used.

Histological Technique for Tissues of the Rat. (C. O. Prickett).—Due to a lack of information on technique for this type of work, tests were made to ascertain the fixatives, methods of dehydration, clearing, embedding, and staining best suited to our needs.

Certain tissues of the rat (liver and kidney) are difficult to handle by the usual methods due to an extreme degree of brittleness. We have overcome this by the use of vacuum dehydration and embedding methods. The apparatus used for fixation, washing, and dehydration is a large dessicator with inlet and outlet valves, while for embedding a Cenco Vacuum Drying oven is used. This oven is particularly well suited to our needs as the temperature is very uniform and constant due to the fact that the vacuum chamber is immersed in an oil bath.

It is of importance in all vacuum procedures with tissues to have a very gradual evacuation and release of the vacuum. To accomplish this we have inserted capillary tips in the pressure tubing between the source of the vacuum and the inlet valve on the oven and also on the release valve. By this means, it takes six minutes to obtain a vacuum of 25 inches and seven minutes to release it.

The vacuum and time required vary with the steps in the procedure and are as follows:

<i>Fixation</i> —15 min. to 6 hrs. (depending upon fixative used)	15 in. vacuum.
<i>Washing</i> —15 min. to 6 hrs.	20 in. vacuum.
<i>Dehydration</i> —70 per cent alcohol— $\frac{1}{2}$ to 2 hrs.	25 in. vacuum.
—90 per cent alcohol— $\frac{1}{2}$ to 2 hrs.	25 in. vacuum.
<i>Clearing</i> —15 min.—2 hrs.	25 in. vacuum.
<i>Embedding</i> —Xylol (to remove clearer) 30 min.—	25 in. vacuum.
First paraffin 15 to 30 min.	25 in. vacuum.
Second paraffin 15 to 30 min.	25 in. vacuum.

(If time is not a factor, the fixation and washing should be done in the usual way unless great care is taken in evacuating the tissues very slowly. However, satisfactory results can be obtained by this method).

It is thus seen that the total time required for the completion of this procedure varies between $2\frac{3}{4}$ and 20 hrs. Also by this procedure there is less hardening of the tissues due to prolonged dehydration methods, and the tissues are not "cooked" during the paraffin baths.

The use of thionin (Grübler), 0.1 aqueous, with differentiation in 95 per cent alcohol is recommended for the staining of celloidin sections of the nervous tissues of the rat. The meta-chromatic effects produced by this stain are very desirable and the tigroid substance is brought out much clearer.

Anilin, C. P., is satisfactory as a clearing agent for rat tissues. It clears well from 70 per cent alcohol.

Technical procedures have also been developed for the use of double embedding with paraffin and celloidin. This enables one to cut celloidin sections at 2 micra.

Relation of Basal Diets to the Pathology of Rats Receiving an Insufficient Supply of Vitamin G. (C. O. Prickett).—A variation in the site and intensity of the pathology dependent upon the type of basal diet used has been observed in rats receiving an insufficiency of vitamin G. The rats were kept on the experimental diets approximately 20 weeks. Each rat received in addition to the basal diet 0.05 gms. of vitamin B solid daily.

The composition of the basal diets is shown in Table 11.

TABLE 11.—Composition of Basal Diets

Ingredients	Percentage composition		
	Diet 2 B	Diet 3 G	Diet 10 G
Casein (purified)	18.0	18.0	32.0
Salts	3.7	4.0	7.0
Agar	1.0	1.0	1.8
Cornstarch	70.3	-----	-----
Sucrose	-----	77.0	-----
Lard (Silver Leaf)	-----	-----	59.2
Butterfat	5.0	-----	-----
Cod Liver Oil	2.0	*	*

*Rats on diets 3 G and 10 G receive cod liver oil fed separately 0.10 ml. per rat daily.

Diet 2 B.—In rats receiving this diet the most constant lesion visible in the gross was a conjunctivitis which affected one or

both eyes, and usually persisted throughout the experiment. Alopecia on the sides and ventral surface of the body was quite common. The skin in these areas was particularly dry and scaly and the epidermis showed a tendency to slough, often in large flakes. In most cases there was a marked salivation and serous rhinitis. Associated with this condition was a fissuring of the canthi of the mouth. The lips and external nares became encrusted with a greenlike mass of food and fluid, often to such an extent as to completely close the nares. Inflammation and ulceration of the tongue were common. The ulceration was in most cases confined to the ventral surface of the tip, while the inflammation usually involved the whole organ. Edema of the extremities with arthritis and sloughing of the epithelium was occasionally seen. About half of the rats in this group evidenced a prolapse of the penis. During the course of the experiment the organ usually atrophied and, in some cases, became infected.

At necropsy the heart and lungs appeared normal as did the neck glands. The liver usually appeared congested and the spleen small and smooth. The stomach was distended with gas. The duodenum was congested and petechial hemorrhages were often visible in its walls. The jejunum appeared as the most normal portion of the intestine. The ileum was discolored with a yellow frothy semifluid substance.

Microscopically, all organs examined showed a marked decrease in their connective tissue content; in the liver particularly, the interlobular connective tissue had practically disappeared. The intestinal tract showed congestion throughout. In the ileum there was usually a mild enteritis. The muscular layers were atrophied and the ganglion cells of the sympathetic plexuses shrunken and pale-staining. The pancreas appeared normal except for the decrease in its connective tissue content. The kidneys evidenced a mild tubular nephritis and, in some cases, a mild glomerulonephritis. The skin showed evidence of a sloughing of the epidermis in some cases. In others, there was excessive keratinization. The tongue gave a typical picture of ulceration.

Diet 3 G.—This diet produced a picture intermediate between the marked external lesions of Diet 2 B and the marked internal lesions of Diet 10 G. Conjunctivitis, alopecia, serous rhinitis, and prolapsed penis were found as in Diet 2 B but were not as severe. There was less evidence of salivation and seldom any arthritis.

At necropsy the heart and lungs appeared normal as did the neck glands. The liver appeared congested in some cases and in others evidenced a gray-white mottling. The stomach was distended with a curdy fluid and the intestines showed evidences of congestion and gelatinization and, in the ileum, were usually stained with a mucous-like fluid which varied in color from a red-orange to dirty brown. This material was not frothy as in

Diet 2 B. The spleen appeared small and smooth. The kidneys appeared normal in most cases, but in a few cases evidenced a gray-white mottling similar to the liver.

Microscopically, the liver appeared congested in all cases observed. In the livers which appeared mottled in the gross, the cells appeared rounded, pale staining, the nucleus was pushed to one side of the cell, the cell membrane was definitely thickened and the cytoplasm appeared filled with globules of varying sizes. The most marked change was in the periportal and the least in the central cells. Sudan III stains of similar livers showed the presence of an abnormal amount of fat. The intestines showed evidences of congestion, atrophy of the muscular coats, and degenerative changes in the mucosa. The sympathetic ganglia were shrunken and pale staining. The spleen appeared atrophic. The connective tissue septa were noticeable decreased. The kidneys showed a mild degree of tubular nephritis and in some cases glomerulonephritis. In those kidneys which presented the mottled appearance the cells were pale staining, large, and showed evidence of fatty change on Sudan III staining.

Diet 10 G.—This diet produced very few lesions externally as compared with either 2B or 3 G. The most marked were alopecia on the dorsal surface of the hips and sides of the animal, and hemorrhagic rhinitis. The skin was dry, but did not tend to be as scaly as the skin of rats on diet 2 B or 3 G. There was evidence of a marked staining of urine.

At necropsy the heart and lungs appeared congested, and in some cases evidenced a mottling similar but not as severe as that found in rats on Diet 3 G. The stomach was usually distended with gas, and the intestinal tract as a whole was congested. There was marked evidence of discoloring and gelatinization. This condition involved in some cases the whole of the tract and did not confine itself to the ileum as in the other diets. Petechial hemorrhages were commonly visible at intervals throughout the affected area. The pancreas appeared congested and the spleen small and smooth. The kidneys appeared normal.

Microscopically, the liver in most cases showed marked congestion and in those livers which appeared mottled in the gross it was found that they presented a picture similar to the livers found in rats on the 3 G diets. However, these changes were not as severe, consisting only of globules in the cytoplasm and a rounding and enlarging of the cells. Sudan III stain showed that these globules contained fats. The pancreas presented a vacuolated appearance. This vacuolization had no particular distribution. The islet tissue appeared normal. Sudan III staining was not done on this tissue. The spleen appeared atrophic. The stomach appeared normal in most cases, but occasionally petechial hemorrhages were observed in the submucosa. The intestines, particularly the ileum, evidenced marked degenerative changes in the mucosa as well as atrophy of the muscle layers

and shrunken and pale staining ganglion cells of the sympathetic plexuses. The damage was greatest in the area where discoloration was observed. The kidneys showed a moderate degree of tubular nephritis.

The pathological picture of all three diets was complicated by a hydrocephalic condition which in some cases made it impossible to study the brain tissue. We are uncertain as to the effect this condition may have had on the symptomatology and pathology observed during the course of the experiment. The rats showed no outward evidence of the hydrocephalus and it may have had no influence on the general picture. However, it is well to bear in mind that this complication was present.

Studies on Hydrocephalus Occurring in Rats on Experimental and Stock Diets. (C. O. Prickett).—A hydrocephalus was first observed in rats which had been on a vitamin G deficient diet for approximately 20 weeks. It later became such a constant finding that it was decided to determine whether the rats affected came from any particular group. Up to the writing 79 out of approximately 150 necropsies have shown hydrocephalus to a variable extent.

It was found that all the rats evidencing this condition were from a line of breeding which traced back to a female obtained from the Wistar Institute in 1925. This rat was one of 10 females purchased at that time, but, as she was the best breeder, her progeny represented a major portion of our stock colony. Rats showing hydrocephalus have been traced back three generations, each generation of which has evidenced the hydrocephalus.

There was no outward evidence of hydrocephalus in the rats observed. As a whole there was surprisingly little symptomatology for the amount of damage done to the brain.

On frontal section of the brain after fixation, the ventricles were found to be dilated to a variable extent. In some cases the dilation was barely visible to the naked eye, and in others had progressed so far that all that remained of the cortex of the cerebral hemispheres was a thin film of tissue. The lateral ventricles were the only part of the brain to be affected. In no case was there any involvement of the third or fourth ventricle or spinal cord.

Microscopically, the picture was typical of that described for human hydrocephalus. In the milder cases there was atrophy of ganglion cells of the cerebral cortex and slight compression. The white matter was compressed to a greater extent than the gray matter. In the more advanced cases the white matter was found to have practically disappeared and the gray matter compressed to a thin membrane. The cortical layers were undistinguishable. The ganglion cells of the cortex were atrophied and had lost their processes. The damage seemed to confine itself largely to the cortex, little damage being done to the basal

ganglia. The ependyma of the lateral ventricles appeared hyperplastic. Three and sometimes four layers of ependymal cells were visible. Heterotopisms of the tips of the anterior horns of the lateral ventricles were common.

In the light of the small amount of work done, we can offer no suggestions as to the cause of this condition. Further studies are under way.

Effect of pH Value Upon Stability of Vitamin G. (W. D. Salmon).—Last year we reported that vitamin G, as measured by its growth-promoting effect, is less stable to heat in alkaline than in acid solution. One frequently finds in the literature, the designation of vitamin G as a heat-stable, alkali-stable factor. This suggested the thought that possibly the inactivation of vitamin G by alkali might be a reversible reaction. Thus in cases where the preparations were rendered sufficiently acid before concentration and subsequent to the treatment with alkali the activity might be restored.

To test this theory two kilos of yeast were extracted with 51 per cent (by weight) alcohol, the extract concentrated *in vacuo* and divided into four aliquots. One aliquot was adjusted to pH 6.80 and dried on cornstarch according to our usual method. The three remaining aliquots were adjusted to pH 2.40, 9.70, and 9.70 respectively and autoclaved at 120-124° C. for four hours. One alkaline aliquot (autoclaved at pH 9.70) was then brought to pH 2.50 and digested at 95-100° C. for four hours. All three aliquots were then brought to pH 6.80 and dried in the same manner as the control which had not been autoclaved. The NaCl concentration was made uniform throughout the series.

These preparations were tested at two different levels on the basis of a daily dosage of 75 mgms. and 150 mgms. respectively per rat. Two basal diets were used, Diet 2 B and Diet 3 G, the former containing starch and the latter sucrose as the

TABLE 12.—Average Gains of Rats for First Week and for Following Six Weeks

Treatment of extract	Daily dosage per rat	Average gain per rat	
		First week of test	Next six weeks
Control	Mgms. 75	Gms. 10	Gms. 21
Alkaline (pH 9.70)	75	7.5	5.5
Acid (pH 2.40)	75	8	16.5
Alkaline + acid (pH 9.70 then pH 2.50)	75	8	7
Control	150	17	52
Alkaline (pH 9.70)	150	11	22
Acid (pH 2.40)	150	13	37
Alkaline + acid (pH 9.70 then pH 2.50)	150	10	22.5

carbohydrate constituent. (See Table 11 for composition of diets). Our standard vitamin B solid which is a fullers' earth adsorbate from an extract of white corn was used as the source of vitamin B. The gains on the two diets were averaged in Table 12, there being no significant differences in the rate of gain on the two diets.

The results are in accord with results previously obtained in this laboratory in-so-far as they show that autoclaving is more destructive to the growth-promoting action of yeast extracts under alkaline than under acid conditions. The comparisons are less striking than we have previously obtained, due not to the fact that any better growth was produced by the alkaline extracts but to a smaller rate of growth on the untreated and the acid extracts than were previously produced by similar preparations. Furthermore, it is clearly evident that the alkaline extract was not improved by the subsequent acid treatment, thus lending no support to the theory of a reversible inactivating reaction.

An interesting feature of all our experiments where yeast extracts have been subjected to various treatments, has been the stimulation of food consumption and consequent gains in weight of the animals the first week the extracts are fed. This is illustrated particularly well in this experiment on the 75 mgm.-dosage of the alkaline and the alkaline + acid preparations; the gains the first week were greater than for the entire six-week period excluding the first week. This can not be attributed to vitamin stores of the animals because they were subjected to a preliminary depletion period of two weeks and were practically stationary in weight when the test proper was begun. Whatever may be the cause, it seems that the gains made the first week after the feeding of the test material is begun should be disregarded in evaluating the vitamin G-potency of a material.

Another interesting feature of these tests, was the occurrence of several cases of scaly feet and tails. In some cases the tails became constricted, resulting in congestion followed by a dry gangrene and sloughing of the tip. Such cases occurred even on the Diet 2 B which contains five per cent of butterfat and two per cent of cod liver oil besides the corn starch and casein which had not been extracted with a lipid solvent.

Symptomatology of Rats Receiving Varying Low Levels of Yeast. (W. D. Salmon).—In 1928 we reported that on certain preparations as sources of vitamin G there was not a good correlation between the growth rate and the prevention of pellagra-like lesions in rats. Sherman and his co-workers have suggested that if the diet is entirely free from vitamin G, rats do not live sufficiently long to develop the characteristic pellagra-like symptoms but that, if a small amount of this factor is present, life is prolonged and the pellagra-like condition develops. Our experiments with extracts of yeast and of leaves of leguminous plants

have indicated a different explanation: That vitamin G consists of two substances or groups of substances; one group will support a considerable rate of growth extending through a period of six weeks or longer but will not prevent the occurrence of certain forms of dermatitis and ophthalmia; the other group is necessary for the prevention of various forms of lesions which are commonly designated as pellagra-like. The latter group is necessarily essential for continued normal growth, but either is not required for the temporary period of growth mentioned, or our rats have a sufficient body reserve of this group to enable them to make considerable growth.

In a further study of this problem five groups of four rats each were fed Diet 2 B. The respective supplements given to the different groups in terms of daily dosage per rat were as follows: (1) 50 mgms. vitamin B solid; (2) 50 mgms. vitamin B solid and 10 mgs. brewers' yeast; (3) 20 mgms. brewers' yeast; (4) 50 mgms. brewers' yeast; (5) 50 mgms. vitamin B solid and 50 mgms. bakers' yeast which had been heated for 45 hours at 140°C. No vitamin B solid was supplied to the groups receiving 20 or 50 mgms. of brewers' yeast because previous tests on the sample of yeast used showed that sufficient vitamin B was furnished by these dosages.

The rats in Groups 1, 2, and 3 made practically no gains in weight. Group 1 began to decline in weight somewhat earlier than Groups 2 and 3. The rates of gain in Groups 4 and 5 were quite similar, the average gain per rat in 12 weeks being 22 gms. for Group 4 and 26 gms. for Group 5.

There were striking differences, however, in the condition of the animals in the various groups. Those in Group 1 developed conjunctivitis, some alopecia, stomatitis, salivation and emaciation which is characteristic for rats on Diet 2 B with our standard vitamin B solid. No dermatitis except a dry, wrinkled condition and slight scaliness of the skin was apparent. The rats in Group 2 developed a similar conjunctivitis and alopecia but none of the other symptoms. In Group 3 there were no symptoms except a slight scaliness of the fore feet on two of the rats. In Group 4 no abnormal symptoms appeared except that it was evident that the rats were making a very subnormal rate of growth. In Group 5, however, there developed in all four rats a severe conjunctivitis and blepharitis with marked evidence of infection resulting in a complete closing of the eyes; alopecia areata occurred on all rats in this group; there was a marked exfoliative dermatitis which was most severe on the sides of face and dorsal surfaces of the fore feet, and two rats developed a severe arthritis in the toes of the fore feet as well as ulceration of the tongue and the buccal mucosa.

The symptoms in Group 5 suggest that this is merely a less severe form of the condition described below under the Boas syndrome. (The rats in Group 5 received a basal diet containing casein which had been extracted with acidulated water but

which had not been heated; it also contained corn starch as the carbohydrate constituent. Moreover, due to a smaller supply of vitamin G these rats made less growth than the rats which developed the severe form of the Boas syndrome. These variations may explain the difference in the intensity of the symptoms.)

On the basis of such results it is difficult to avoid the conclusion that the relatively heat-stable fraction, vitamin G, may itself contain a relatively labile and a relatively stable fraction; the relatively labile fraction is apparently related to the prevention of certain forms of eye- and skin-lesions in the rat. Such a hypothesis is apparently in line with our previous findings that when extracts of yeast or plant leaves are concentrated and subjected to certain chemical procedures, their growth-promoting properties may be largely retained without a comparable retention of their ability to prevent certain so-called pellagra-like symptoms. While we have not made careful comparisons with control groups of rats, we have the impression from results on large numbers of rats which have received autoclaved yeast (autoclaved four to eight hours at 15 to 17 pounds) as a source of vitamin G that autoclaving yeast in a moist condition is less destructive to the relatively labile "dermatitis-preventing" factor than is heating the yeast in dry form in an electric oven. It is possible that the destruction is not a simple temperature effect.

Rats on Casein Diet Develop a Condition Resembling the Egg-White Syndrome of Boas. (W. D. Salmon).—In 1927 Boas described a very interesting symptom-complex in rats receiving a diet containing dried egg-white as the source of protein. Findlay and Stern, and Parsons have more recently obtained somewhat comparable results with egg-white diets. No one has yet described an analogous condition in rats receiving diets containing casein as the source of protein. It has been of considerable interest to us, therefore, to have produced in several groups of rats during the past two years, a condition which is similar to the Boas syndrome in many of its aspects. We do not even yet understand the condition sufficiently to enable us to reproduce it in its most severe form in every group of rats but the results obtained seem to warrant a preliminary report.

The condition was first produced in a group of 12 rats that had a change in their dietary history while the experiment was in progress. They were started at an average weight of 50 gms. on Diet 2 B. After a depletion period of two weeks, they received a supplementary addition of 50 mgms. of our standard vitamin B solid and 150 mgms. of bakers' yeast per rat daily. The yeast had been extracted with gasoline and then heated for four hours at 130-140° C. After six weeks the rats began to develop a conjunctivitis and a few patches of dermatitis.

In order to determine if there was any possibility of a deficiency of vitamin A in the diet they were transferred to a vita-

min A-free diet (Diet A-2) with Squibbs medicinal cod liver oil given separate from the basal diet. The composition of Diet A-2 was as follows: casein 18, agar 1, salt (O & M) 4, and sucrose 77 per cent.

The casein had been extracted four times with boiling alcohol. Certain variations were made in the level of cod liver oil but as these were found to have no relation to the condition they will not be discussed. Following the change in diet there was a gradual increase in the severity of the symptoms which will be described below.

The results from this first group suggested that the partial extraction of lipins from the casein and yeast had produced the condition. Later tests with casein and yeast which had been more nearly freed of lipins proved this view to be erroneous. The condition was reproduced, however, on a basal diet similar to Diet A-2 except that the casein was extracted with acidulated water, dried, and then heated to 130° C. for 48 hours; it was found that either the heated yeast or dried Vegex in dosages of 150-200 mgms. per rat daily could be used as the source of vitamin G. Larger dosages of the Vegex were not tried but dosages of 500 mgms. even of yeast that had been heated 45 hours at 130-140° C. were definitely protective. On the basis of the later work it seems reasonable to presume that the heating of (in the process of extracting with boiling alcohol) the casein used in the first test was a more important factor than the nature of the material which was extracted.

The gross symptoms present a striking picture. The rats average about 10 gms. gain per week until they are approximately double their initial weight of 45 to 50 gms. when the weight curves tend to plateau; there is then very little change in weight until the final one to two weeks of life when there is a loss of 20 to 30 per cent in weight. Usually the first noticeable symptom is a conjunctivitis and blepharitis with excessive lacrimation. The secretion becomes pus-like and causes the lids to adhere so that by the seventh or eighth week the eyes may be permanently closed.

There is a general exfoliative dermatitis accompanied by a seborrheic secretion which causes the hair to cling together in tufts. The desquamating epithelial scales are for the most part white or light-yellow but in some cases large patches of elevated epithelium which are reddish-brown in color appear over the dorsal surface of the body and in places this epithelium erodes leaving a raw surface exposed. In the final stages hemorrhages appear in the skin and the blood may reach the surface through deep fissures; examination at necropsy shows that these hemorrhages are in the cutaneous tissues, the adjacent subcutaneous tissues showing only a moderate congestion. Reddish-brown eschars or incrustations about the masseteric and mandibular regions are common and the oral commissures are frequently

fissured. The exfoliative dermatitis is quite severe on the feet, and the fore feet are frequently edematous and arthritic. The hock joints are also sometimes involved. The tails are always rough and scaly and a dry gangrene sometimes results in a sloughing of the tip.

Areas of alopecia may appear early in the history, or the hair may be retained until the other symptoms are well developed and then a large portion of the coat lost within a period of a few days. The hair sometimes assumes a lanugoid appearance.

Besides the hemorrhages in the skin there is invariably a hemorrhagic rhinitis and blood stained urine. Sometimes in the final stages the urine may appear as drops of blood.

After the condition is well developed the rats appear to try to hide; they will crouch in a remote corner of the cage or rest across the rim of the feed cup with the head suspended inside the cup. This may be interrupted with short periods of abnormal activity when the animal will dash excitedly about the cage, now and then assuming a kangaroo-like posture and exhibiting rapid paddling movements with the front feet. They usually object to being handled and protest particularly if pressure is applied to the dorsal portion of the body.

The length of life varies but usually ranges from 10 to 16 weeks. Necropsies were made on only a few cases. Macroscopically there was little evidence of marked pathological changes. The absence of fat deposits, a mild gastro-enteritis, some congestion in the kidneys, and the presence of pneumonic areas in the lungs were the chief findings. No histological studies have been made.

We are uncertain as to whether this condition should be considered a new syndrome or a more severe and possibly a more typical form of pellagra dermatitis. We believe the type of dermatitis to be nearer the form of dermatitis exhibited by human pellagrins than are the irregular cases of dermatitis which occur in rats that are entirely deprived of vitamin G. Indeed it is possible that the explanation of the difficulty in producing severe cases of dermatitis in rats on a vitamin G-free diet is that the casein, the source of vitamin B used, or the other constituents of the diets may supply amounts of a "dermatitis-preventing" factor or factors which are almost adequate for rats that do not make considerable growth. At any rate it seems that the diet must contain sufficient vitamin G to produce considerable initial gains in weight before the condition described above can be produced. To supply sufficient vitamin G to meet this requirement without at the same time supplying enough of the other protective factor to prevent the occurrence of the dermatitis, presents a serious problem until a chemical procedure for an approximately quantitative separation can be developed.

Relation of Vitamin B to Carbohydrate Metabolism. (G. A. Schrader).—In recent years the early idea of Funk that vitamin

B was related to carbohydrate utilization has received added confirmation. Especially has this been true of the work done by Evans and Lepkovsky and by workers in this laboratory.

If animals are placed on a diet supposedly adequate except for vitamin B (or vitamins B) the time at which they succumb due to the deficiency has been found to vary with the source of energy. That is, if a carbohydrate such as sucrose, dextrin, or starch forms the main energy source, beriberi or death due to vitamin B-deficiency occurs quite quickly. However, the above workers have found that if fat is the main energy source animals will survive and grow for a considerable period of time on a very low vitamin B intake.

There are other results that may be considered as indirectly indicating such a relationship. The somewhat high blood sugar and brain lactic acid of vitamin B deficient pigeons, as reported by Kinnersley and Peters, may possibly be associated with a disturbance in some phase of carbohydrate utilization. Likewise, the respiratory quotient (0.75) obtained by Anderson and Kulp for "polyneuritic" hens showed that only fat was being metabolized. On the other hand much evidence has been presented which showed no relationship.

We have assumed as a working hypothesis that vitamin B functions in some phase of carbohydrate utilization. The question logically follows as to what stage or stages it is required. Evidence had been previously presented that food absorption is not interfered with. Thus we have been concerned mainly with the later stages of carbohydrate metabolism. Our method of approach has mainly been to deplete the stores of vitamin B in the experimental animals first. They were then subjected to various treatments and the effect determined. To date our evidence has been secured from a study and comparison of the blood sugar and glycogen release or formation from the administration of d-glucose or r-lactic acid. Both the rat and the pigeon, normal and vitamin B-deficient, have been used. Glycogen determinations have been made on approximately 200 rats and 30 pigeons. A like number of blood sugar analyses on rats have been made, and approximately 100 on pigeons.

Only the high sucrose vitamin B-deficient diet 3-G has been used in the rat work so far. In some cases they were started on this ration at 45 grams weight; in others at 100 grams. After the first two-week preliminary depletion period vitamin G was added as a separate daily supplement in the form of thoroughly autoclaved yeast. At this time the rats were divided into two groups, placed in individual cages, with one group receiving a further supplement of a vitamin B-solid preparation. These rats thus served as controls in the final analysis. As a further control normal rats of a similar age or weight were also used.

Likewise, the pigeons used consisted of those receiving our

standard synthetic B-deficient diet, those on the same diet plus vitamin B, and those on a normal diet.

It was first necessary to select and standardize all procedures. This was true for the preparation of the animals as well as the administration of glucose or lactic acid and the subsequent chemical analyses. Not only was it necessary to establish the most suitable amounts of the above substances that could be administered, but also the best method of administration. It was found that even though the lactic acid was half-neutralized by NaOH a dose greater than 250 milligrams per rat was harmful. The best level of glucose was found to be from 125 to 500 milligrams per rat. The method of administration of both as finally selected was oral and was done by the use of a syringe to which was attached a number 8 (German) catheter. Thus when the jaws of the rat were held open it was relatively easy to insert the vaselined catheter down the esophagus and into the stomach. The rats were killed four hours after the administration.

Although controls of normal rats and those receiving 3-G diets were used, further controls within each group were also used. In order to insure glycogen depletion a previous 24 hour starvation period was adopted. A few animals were killed at this hour to serve as "initial" controls and then following the four-hour post-administration period other controls were killed, serving as "final" controls.

In the pigeon work the same procedure was followed, except that the solutions were administered orally with a medicine dropper. When insulin was administered this was done by subcutaneous injection with a hypodermic needle.

Blood for sugar analyses was usually collected in duplicate on pigeons and in single samples from the rats. The blood was obtained from the wing vein in the former and from the tail in the latter, and was collected on paraffin. As an added means of preventing coagulation a few milligrams of sodium fluoride were used.

The blood sugar method finally adopted was the Hagedorn-Jensen method. This is a micro-method enabling one to use 0.1 milligram blood for each determination. This method has been found to be simple and reliable. However, it was thoroughly tested with standard glucose solutions before its final adoption.

Glycogen determinations were always made on the rat liver and on the body minus the alimentary tract. The rat was killed by crushing its head, the abdominal and thoracic cavities quickly opened and the liver and alimentary tract removed. The liver and body were then placed in separate extraction flasks containing boiling 60 per cent KOH and were boiled with shaking until complete solution occurred. The whole procedure up to the immersion of the tissues in the KOH was done in approximately 30 seconds.

In the glycogen work on pigeons they were killed by decapi-

tation, the liver was removed, and 10 to 15 grams of breast muscle was taken for a representative body glycogen value. The procedure likewise took from 30 to 45 seconds.

Pflüger's method was used for the glycogen preparations. The glycogen was then hydrolyzed with HCL, neutralized to litmus with KOH, and the resulting glucose determined by a semi-macro modification of the above Hagedorn-Jensen method. A more complete discussion of the author's modification will be found in an accompanying article.

No specific data will be presented at this time as the work has not reached a point at which any certain interpretations can be made safely. However, the results are briefly listed in the following general observations.

- (1) Beriberi was usually accompanied by a high blood sugar in the pigeon, especially during the final stages before death. In some cases a value twice that of the normal bird was observed. In the rat there was little, if any, increase in the blood sugar. This discrepancy can possibly be explained in that the pigeons were force-fed, whereas, the rats were not. The rats consumed very little food, especially during the last week to ten days.
- (2) Beriberi pigeons appeared to be more susceptible to insulin shock than did normal birds. This was found to be due, in part at least, to the power of the insulin to lower the blood sugar. The symptoms of insulin shock in the vitamin B-deficient bird resembled the actual polyneuritic symptoms. Insulin shock was apparently produced at a higher blood sugar level in the vitamin B-deficient bird than in the normal. However, the simultaneous administration of glucose and insulin prevented such a pronounced decrease in the blood sugar and likewise prevented insulin shock. It thus appeared that the vitamin B-deficient bird could still absorb glucose from the alimentary tract. No similar work has been done on the rat as yet.
- (3) The cure of beriberi in the pigeon by the administration of brewers' yeast was accompanied by a return of the blood sugar to normal values in from two to three days.
- (4) Starvation caused a depletion of liver and body glycogen in the vitamin B-deficient rat as well as in the normal rat. In 24 hours the liver glycogen was reduced to practically zero in both cases.
- (5) Both d-glucose and r-lactic acid (one-half neutralized with NaOH) induced glycogen formation in vitamin B-deficient as well as normal rats, although quantitative differences may exist.
- (6) In cases where large amounts of glucose or r-lactic acid were administered to rats, death often resulted. This was especially true for the higher lactic acid levels. Upon autopsy the stomachs and small intestines were found to be

decidedly hemorrhaged. If death did not occur, very high blood sugars were found. This again showed that the materials were absorbed, and in the case of lactic acid apparently converted into blood sugar.

- (7) Pigeons with advanced beriberi, that is the convulsive stage, often were found to have a very high liver glycogen, as well as the high blood sugar previously mentioned.

In conclusion we can only say that the major part of the evidence thus far obtained indicates no serious defect in the glycogen formation or glycogen liberation stages in the vitamin B-deficient animal. The evidence, however, is not yet convincing. The fact that the pigeon and rat results have not always been in harmony may be due to: (1) The pigeons are force-fed, whereas, the rats are not, and (2) the only ration used in the rat work to date has been the high sucrose ration 3-G upon which the rats usually die before exhibiting actual polyneuritis. We are at present trying to develop a ration which will consistently produce actual beriberi in the rat.

A Modification of the Hagedorn-Jensen Method for Semi-Macro Quantities of Glucose. (G. A. Schrader).—During the course of the present work a reliable and short procedure for the determination of glucose was required. Inasmuch as the glucose was derived from fair amounts of glycogen this method must be one which could determine a maximum of approximately ten milligrams. That is, our work really required a semi-macro procedure. We had already adopted the Hagedorn-Jensen method (1923) for the determination of blood sugar. It is a micro-method, which is very satisfactory due to the sharp iodometric end-point and the method of heating, as well as being reliable and accurate, and it was believed that it would also be very satisfactory as a macro-method if a suitable modification could be made.

A search of the literature revealed that Hanes (1929) had adapted the Hagedorn-Jensen method to the determination of one to six milligrams of glucose. However, upon studying his procedure it appeared that it was cumbersome because of the normality of the reagents that he used. Thus we found that he used such normalities as N/40 potassium ferricyanide, N/44 potassium iodate, and N/75 sodium thiosulfate. To make matters worse he finally calculated all results in terms of N/100 sodium thiosulfate. Furthermore, he found that glucose did not reduce the potassium ferricyanide in direct proportion and, consequently, upon plotting results he secured a curve instead of a straight line. This in itself was unusual so it was thought best to select our own modification and to subject it to a thorough test, using his modification, however, as a basis. The method as finally worked out is applicable to approximately eight milligrams of glucose.

Theory and Principles.—The principles and reagents involved in the above method are relatively simple. Furthermore, the ultimate analysis is an iodometric titration which is notably simple and reliable.

In brief, the determination of the sugar depends, as in most other methods, upon the ease with which the sugar is oxidized. In this method the oxidizing agent is standard potassium ferricyanide. The ferricyanide is reduced to the ferrocyanide, which is conveniently and quantitatively removed by precipitation in acetic acid solution as the double potassium—zinc salt. The unchanged excess ferricyanide is then determined indirectly by its liberation of iodine from potassium iodide; the iodine is subsequently determined by titration with standard sodium thiosulfate. This is compared with a similar determination in which pure water is used in place of the unknown solution. The difference between the two, expressed in terms of the standardized thiosulfate, is the index of the amount of glucose in the unknown.

The oxidation of the sugar is done by heating with the potassium ferricyanide in a boiling water-bath for a definite time, a much better and easier procedure than direct boiling of the solution. The time selected is 15 minutes in which time the oxidation is practically complete. The solutions are then cooled for three minutes and are ready for the iodine liberation and titration.

Reagents.—(A) N/25 Potassium ferricyanide, (approximate). Weight 13.2 grams of potassium ferricyanide and 10.6 grams (approximate) of anhydrous sodium carbonate and make to one liter. Keep two to three days before using and store in the dark.

(B) Potassium iodide. Dissolve 25 grams KI, 50 grams hydrated zinc sulfate and 250 grams sodium chloride in one liter solution. It is best to filter the fresh solution and to store in a dark container in the dark.

(C) 5 per cent Acetic acid.

(D) Soluble starch. Dissolve one gram of soluble starch in 100 cc. of saturated sodium chloride solution. Solution is insured by heating to near boiling.

(E) N/50 Potassium iodate. Weigh accurately 0.7134 grams of potassium iodate and dissolve to one liter with pure water. This solution will keep several months and serves as a convenient and accurate standard for the sodium thiosulfate solution.

(F) N/50 Sodium thiosulfate, (approximate). Prepare fresh daily from a stock N/10 solution.

(G) 2 per cent potassium iodide solution.

Procedure.—(1) Add 5 cc. of (A) to a 6 "XI" pyrex tube by means of an accurate Ostwald-Folin pipette.

(2) Add 10 cc. of the unknown—if less add water to make to 10 cc. mix thoroughly.

(3) Heat 15 minutes in a boiling water-bath.

- (4) Cool 3 minutes in cold water.
- (5) Add 5 cc. of (B). (Not accurately). Mix.
- (6) Add 3 cc. of (C). (Not accurately). Mix.
- (7) Titrate against standard N 50 sodium thiosulfate to a faint yellow color. Add 2 drops of the starch solution, (D), and titrate until blue color just entirely disappears.

All analyses have been made in triplicate.

Controls.—This is the same as the regular determination except that 10 cc. of water replaces the unknown in (2). These must be run each day to counteract the slight deterioration of the N/25 potassium ferricyanide solution.

Blanks.—Blanks should always be run on the reagents, using the same amounts as in the regular procedure. This need not be done every day.

Standardization of the N 50 Sodium Thiosulfate.—Measure accurately 5 cc. of the standard N 50 potassium iodate into each of three test tubes. Add 5 cc. of (G) and titrate with the sodium thiosulfate as above. The actual normality of the thiosulfate can, therefore, be determined accurately and conveniently each day. From the resultant normality the normality factor can quickly be calculated for use in the final calculations.

For example, the triplicate 5 cc. potassium iodate solutions required an average of 5.02 cc. of the approximately N/50 sodium thiosulfate. The normality of the latter is quickly calculated from the indirect proportion: cc. N/50 KIO_3 : cc. approximately N/50 $\text{Na}_2\text{S}_2\text{O}_3$ = unknown normality of the $\text{Na}_2\text{S}_2\text{O}_3$:

known normality of the KIO_3 . Or, in terms of the above example, 5.00 cc. : 5.02 cc. = XN : 0.02N, or $\text{XN} = \frac{5.00 \times 0.02}{5.02}$

= 0.01992N (the actual normality of the solution thiosulfate).

The normality factor (N.F.) = $\frac{0.01992\text{N}}{0.02\text{N}} = 0.996$.

Results.—Chart I shows the results obtained from a thorough study of the method, using pure d-glucose as the standard. It will be noted that the glucose in milligrams is represented in terms of cc. of N/50 sodium thiosulfate. Once the normality factor of the N/50 solution has been established, as above, the final calculations are simple. For example, we have the following data:

Average cc. $\text{Na}_2\text{S}_2\text{O}_3$ for controls	= 9.905 cc.
Average " " blanks	= 0.020 cc.
Net " "	= 9.885 cc.
N. F. = 0.996	
cc. exactly N/50 $\text{Na}_2\text{S}_2\text{O}_3$ = 9.885 x 0.996	= 9.845 cc.
Average cc. $\text{Na}_2\text{S}_2\text{O}_3$ for unknown	= 4.210 cc.
Average cc. " " blanks	= 0.020 cc.
Net cc. "	= 4.190 cc.
cc. exactly N/50 $\text{Na}_2\text{S}_2\text{O}_3$ = 4.190 x 0.996	= 4.173 cc.

Therefore, the sugar in the unknown actually used potassium ferricyanide equivalent to 5.695 cc. of N/50 sodium thiosulfate. The actual amount of sugar, as glucose, can therefore be easily determined by reference to the chart. When this is done it is found that the solution contained 3.51 milligrams glucose.

It is probably unnecessary to add that if the amount of sugar in the solution is too great that aliquots can be selected which will be within the limits of the above method. It is preferable to have from 2 to 5 milligrams of glucose per determination for greatest accuracy.

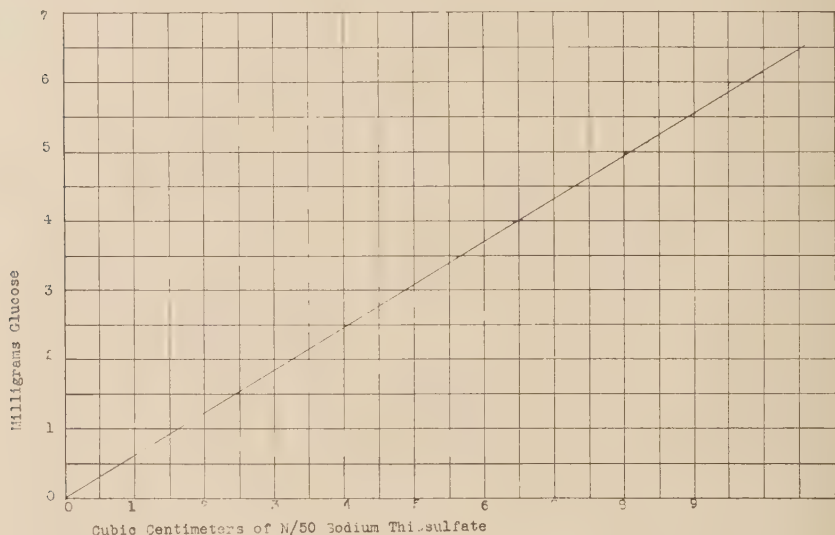


CHART I.—The Relationship between the Amount of Glucose, in Milligrams, and its Oxidation by Potassium Ferricyanide as expressed in Terms of Cubic Centimeters of N/50 Sodium Thiosulfate

The Efficacy of Fats in Decreasing the Vitamin B-Requirement of Pigeons and Rats. (W. D. Salmon and J. G. Goodman).

—Last year we reported that a diet containing 59.2 per cent of Silverleaf lard had a significant effect in decreasing the vitamin B-requirement of rats. Tests this year have shown that a similar diet containing 53.5 per cent of lard likewise reduced the vitamin B-requirement of pigeons. An interesting result was the fact that in the experiments this year two purchases of lard were made. When the birds were changed to the second sample there was a noticeable improvement in their condition; subsequent results showed that it was appreciably more effective in delaying the onset of polyneuritis than was the first sample. Both samples were the same brand and presumably the same grade of lard but the second sample was rather "soft" as compared with the first which was a strictly "hard" lard.

Recent reports from Evans' laboratory have ascribed a peculiar effectiveness to certain natural fats and the glycerides of certain single fatty acids in relation to their vitamin B-sparing action. Cocoanut oil and also the glycerides of myristic and caprylic acid were reported to be most effective. Since butterfat contains about 0.50 per cent of caprylic and 15 to 20 per cent of myristic acid, it seemed, in view of the reported results, that this fat should be quite efficient in decreasing the requirement for vitamin B. A diet containing 59.2 per cent of butterfat was not found to be any more effective, however, than the diet containing the same amount of lard. In fact, rats receiving the butterfat diet have developed beriberi a little earlier on the average than have rats receiving a similar diet containing the second sample of lard mentioned above.

The high-fat diets have appeared to confer less protection against beriberi in rats this year than last. Two factors may be mentioned which offer a possible explanation of the differences. The stock diet used in our breeding colony last year contained five per cent of dried yeast; this has since been omitted so that the young rats used this year may have had a smaller reserve store of vitamin B when placed on experiment. Another and possibly more important factor has been an increase in time of autoclaving the yeast used as the source of vitamin G in these experiments. Whereas, we formerly autoclaved this material four hours at 15 to 17 pounds pressure, we now autoclave eight hours at the same pressure.

When rats receiving the diets containing 59.2 per cent of lard or butterfat became depleted of their reserve store of vitamin B, they exhibited the marked incoordination and paralysis which are generally recognized as characteristic symptoms of vitamin B deficiency in this animal. This is in distinct contrast with rats that receive a high carbohydrate diet which is free from vitamin B; such animals usually die of inanition without presenting a characteristic picture of beriberi.

At the present stage of the investigation, it seems that the vitamin B-requirement of pigeons and rats is significantly less on a high fat than on a high carbohydrate diet; it is apparent, however, that there is a demonstrable requirement for this factor even on a diet containing 59.2 per cent of lard or butterfat. When the reserve store of the vitamin in the body of the animal supplemented by traces that may be obtained from constituents of the diet or occasional ingestion of excreta becomes inadequate to meet the physiologic requirements, characteristic symptoms of vitamin B-deficiency develop and the animal dies.

An Improved Method for Extraction of Vitamin B from a Fullers' Earth Adsorbate. (W. D. Salmon).—Numerous investigators have used fullers' earth as an adsorbent for vitamin B, but a satisfactory eluent for extraction of the active factor from the adsorbate has not been found. Sodium or barium hydroxide

solution has been most frequently used. The marked instability of the vitamin in alkaline solution, however, contra-indicates the use of an alkaline eluent. Consequently, we have developed a method for extraction of the vitamin in acid solution.

The adsorbate is washed first with 20 ml. of H_2O per gm. and then with 20 ml. of 80 per cent (weight) alcohol containing 5 per cent of glacial acetic acid. This preliminary extraction decreases the activity very little. (The adsorbate can apparently be washed with large volumes of H_2O without any marked decrease in the content of vitamin B.) The adsorbate is then extracted with a solution prepared by adding 6 ml. of pyridine and 10 ml. of glacial acetic acid to 84 ml. of 80 per cent (weight) alcohol. The extraction is made at a temperature of 60-65°C. If 8 extractions with 5 ml. of solvent per gm. of adsorbate are made, approximately 20 per cent of the activity remains in the extracted solid; if 16 extractions are made, approximately 13 per cent of the activity remains. The recovery of the extracted vitamin is far better, however, than has been reported for other methods. After the extract is concentrated to a sirup, it is treated in five stages with increasing concentrations of alcohol, the various precipitates being removed and washed with alcohol. The final fraction which is soluble in absolute methyl or ethyl alcohol retains 75 per cent of the activity of the original adsorbate. (The adsorbate used protected 300 gm.-pigeons in daily doses of 15-17 mgms.)

Treatment at this stage with acetone or amyl alcohol results in serious losses in activity, although about 25 per cent of the activity is retained by the amyl alcohol solution from which it can be removed by careful shaking with water.

In connection with these studies the curative pigeon method as developed by Kinnersley and Peters was compared with the protective method as developed in this laboratory. The same synthetic diet was used for both methods of testing. In general the curative method indicated approximately twice the potency for our vitamin preparations that was shown by the protective method. The apparent potency of a given preparation as determined by the curative method was affected by the amount of vitamin administered. However, if the standard was taken as the minimum amount of a substance required per day to produce a cure lasting three to five days, the results were sufficiently accurate to make it a useful and convenient method for following the fractionation of an extract.

We have noted in some cases where curative tests were repeated on pigeons at frequent intervals, that a peculiar incoordination of the muscles of the wings and legs developed which did not readily respond to vitamin therapy. If the usual curative dose of vitamin B was given, the convulsions and head retraction would be cured and the bird would retain food and make gains in weight, but there would be no immediate improvement in the wing and leg condition.

The wing condition was characterized by inability of the bird to hold the wings folded against the body in their normal position; instead, the wings were slightly spread or drooped and were almost continuously in a tremor. The legs might merely evidence general weakness, in which case the bird would exhibit a staggering gait and be unable to stand still unless the body was supported against the side of the cage; such birds might usually be found lying on the floor of the cage, partially supporting the body on the hock joints and the back of the shanks. In the more severe cases the bird was entirely unable to stand, the legs sprawling either forward or backward or sometimes one leg forward and one backward. The hock joint and the portion below the hock joint seemed to be affected more than the portion above this joint. If such birds were given a generous dose of vitamin B daily, little improvement was observed under 18 to 21 days; after this time improvement was relatively rapid and the birds usually appeared normal again within the next one to two weeks. One may raise the question if it is not only in such cases as these that actual nerve lesions occur; the rapidity of the cure which follows the administration of vitamin B in cases of acute beriberi in pigeons is entirely incongruous with the idea of the symptoms being due to a degeneration of nervous tissue.

Influence of the Method of Curing Kudzu Hay on Its Vitamin A Content. (W. E. Sewell and G. J. Cottier).—The kudzu hay used was cured in September 1930 in the following manner: Sample 1, regular field cured; sample 2, cured in the cock; sample 3, cured in the shade. After the hay was cured all samples were dried in an oven at 60 degrees for five hours and then ground to pass through a 20 mesh screen.

The method used for the vitamin A tests is the standard one of depleting young rats of their vitamin A store on a vitamin A-free diet and then supplying the material to be tested.

When the rat weights became constant the vitamin A-free diet was supplemented with the dry, ground hay. Each of the three samples of hay were tested at levels of .0025 grams, .0050 grams, and .0075 grams per rat daily.

These levels were too low to constitute a Sherman unit. The results indicate, however, that in vitamin A potency shade-cured, cock-cured, and sun-cured hays rank in the order named.

Efficient Rations for Laying Hens. (G. A. Trollope, D. F. King, C. T. Bailey).—The object of the project was to study the utilization of home grown feed stuffs in simplified poultry rations for egg production. The first phase of the project dealt with rations and management applicable to farm flock conditions. Six pens of 40 S. C. White Leghorns each were under test for a period of seven months. The cornmeal-milk ration gave better results than any of the other rations, as is indicated by Table 13.

TABLE 13.—Egg Production, Profit, Mortality, and Hatchability of Eggs as Influenced by Different Rations

Lots	Feed used	Eggs produced per bird	Return per bird above feed cost	Number birds died	Per cent hatchability
1	Yellow corn meal, mineral, and skim milk to drink	107.1	\$1.05	10	77.7
2	Yellow corn meal, mineral, and meat scraps	66.5	\$0.67	15	61.4
3	Yellow corn meal, mineral, gr. oat groats and meat scraps	69.6	\$0.70	16	63.5
4	Yellow corn meal, mineral, gr. oats and fish meal	60.8	\$0.67	9	61.0
5	Yellow corn meal, mineral, gr. oats and cottonseed meal	69.9	\$0.64	17	19.5
6	Complex egg mash (commercial)	80.3	\$0.70	14	70.6

The second phase of the project was a study of the effects of substituting ground soybean hay for alfalfa leaf meal. Four lots of 80 S. C. White Leghorn pullets each were under test for a period of eight months. Ground soybean hay compared favorably with alfalfa leaf meal when used to supplement either yellow or white corn.

Simplified Rations for Chicks. (G. A. Trollope, D. F. King, C. T. Bailey).—Three feeding trials were conducted to determine the relative efficiency of simple and complex rations for chicks. A summary of the trials shows that a ration consisting of corn, shorts, buttermilk, and minerals gave as good results as a ration of corn, oat groats, shorts, buttermilk, meat scraps, linseed meal, alfalfa meal, and minerals. Varied unsuccessful results were secured when cottonseed meal was used as a protein supplement in the simplified chick rations.

BOTANY AND PLANT PATHOLOGY

Diseases of Winter Peas and Vetches Caused by *Mycosphaerella* and *Ascochyta*. (J. L. Seal).—These diseases were generally common during the past season but were not of epidemic proportion other than possible exception of local areas. Although Oregon grown seed showed approximately .03 per cent disease and locally grown seed 8 per cent disease, when the two kinds of seed were planted on adjoining areas, the resulting plants showed about equal amounts of disease in late spring. Small amounts of initial infections were able to cause an abundance of disease during the growing season.

Locally grown pea seed were treated with 40 different seed treatments, but in no case was a treatment of value. The organ-

isms are carried readily in the soil on old plant parts from one season to another. Soil from a field where these legumes had made a failure grew a good crop of plants free of disease after the soil was steam sterilized.

Nematodes, Rhizoctonia and failure of the plants to become inoculated by the proper species of Rhizobium caused considerable trouble.

Studies on Nut Grass. (G. L. Fick and R. Y. Bailey).—A study of the distribution of nut grass tubers in Norfolk sandy loam soil showed that some were found in a layer 14-16 inches deep, but none were found below this depth. The average number of tubers taken from the first 16 inches of a yard-square area was 1,122, of which 1,044 were in the upper 8 inches of soil.

Tubers which were planted in pots early in July formed new tubers and decayed by the middle of November. This indicates that the normal life of an actively sprouting tuber is not more than one growing season.

Results of sprouting tests with tubers taken from different soil depths and planted at depths varying from 8 inches to 5 feet showed that no sprouts were sent to the surface by tubers planted deeper than 3 feet. There was no definite relationship between the depth from which tubers were taken and the depth from which they were able to send sprouts. Nut grass planted in pots on July 2, 1930, and clipped just below the surface of the soil as often as sprouts appeared produced no new tubers during the season. In contrast with this, unclipped nut grass in the same experiment formed 84 new ones from a single tuber.

When the moisture content of the tubers had been reduced to 24 per cent by being exposed to sunlight for 4 days, they failed to germinate. Tubers which were dried at room temperature or in a dessicator failed to germinate after the moisture content was reduced to 15 per cent. Results of germination tests of tubers which had been exposed to temperatures varying from 50 to 90 degrees C. for time periods varying from 1 hour to 8 days, under conditions which prevented the loss of moisture, indicate that the thermal death point is between 50 and 60 degrees C.

ENTOMOLOGY

Turnip Webworm Control. (J. M. Robinson).—Thirteen materials were used in tests to determine the best control for the turnip webworm. Five of these materials, namely, barium fluosilicate, sodium fluosilicate, lead arsenate, calcium arsenate, and cryolite, when applied as a dust, killed one hundred per cent of the larvae. The mortality from other materials tested, namely, magnesium arsenate, zinc arsenate, 4-amino-diphenyl, sodium diphenyl 1-4-mono-sulphate, cuprous cyanide, nicotine sulphate,

pyrethrum, and copper lime, was so low that further tests will not be made.

Eleven materials were tested as sprays to control the turnip webworm larvae. The materials tested were sodium arsenite, pyrethrum, cryolite, calcium arsenate, sodium fluosilicate, lead arsenate, magnesium arsenate, Paris green, zinc arsenate, barium fluosilicate, and nicotine sulphate. Sodium arsenite killed the plants. The other materials applied in solution were valueless as a control for the larvae of the turnip webworm.

The Control of Citrus Insects with Emulsions. (L. L. English).

—*Scale Insects.*—A method has been developed which may give accurate data for the proper timing of oil sprays against scale insects. Removable tanglefoot bands are placed on infested limbs to catch the emerging crawlers. A fresh band is placed in the same place each week and the number of crawlers on the old band is recorded.

Camphor Scale.—Fumigation with calcium cyanide dust was more effective against this insect than one application of 2 per cent oil emulsion. A combination treatment of oil followed by fumigation was slightly more effective than fumigation alone.

Oil Residue.—In experiments with emulsions containing gum, it was found that the amount of oil retained by citrus foliage is approximately a straight line function of the oil concentration of the spray.

Life History and Control of the Cowpea Curculio, (*Chalcodermus aeneus* Boh). (F. S. Arant).—Studies upon the life history and control of the cowpea curculio were begun in 1930. Oviposition was continuous from the middle of June to the first of October, a period coinciding roughly with the fruiting period of the cowpea. Many of the overwintered adults continued to oviposit throughout the season. The laying population was, therefore, greatly increased as the newly emerged females began depositing eggs. An incomplete record gave a maximum of 102 eggs deposited by a single female between June 24 and August 17.

The time required for complete development (egg to adult) varied from 23 to 53 days; the mean was 30.8 days. Approximately 13 days of the mean period were spent within the pea and the remaining 18 days within the soil.

Variety tests were conducted to determine the susceptibility of various varieties to the attack of adults. Thirteen varieties, planted at four different times during the season, were tested. The White Crowders, with 65.1 per cent of the peas punctured, were injured most severely and the Black Crowders, with 20.1 per cent of the peas punctured, were injured least severely of all the varieties tested.

Preliminary cage tests were made to determine the effective-

ness of nine different insecticides in killing adults. Three of these materials, namely, sodium fluosilicate, barium fluosilicate, and lead arsenate, produced a high mortality when dusted upon the foliage of cowpeas. They were slow, however, in their speed of toxic action. The other materials tested, namely, calcium arsenate, magnesium arsenate, cryolite, pyrethrum dust, talc, and 4 amino-di-phenyl, appeared rather ineffective against this insect.

Life History of the Pecan Weevil. (*Curculio caryae*.) (H. S. Swingle).—Life history studies were continued. The adults emerged during August and September. Egg deposition began August 22 and reached the peak during the second week of September. The average number of eggs per female was 11.3, which was less than in the previous year, due to the late date at which the nuts hardened. Larvae began emerging September 26 and continued to emerge until the following spring.

The infestation was approximately twice as heavy as it was in 1930. The percentage of nuts that were wormy was found to vary with the variety, being directly correlated with the time the kernels hardened. The varieties which hardened first were most severely attacked.

At Camp Hill about 45 per cent of the Schleys, Stuarts, and Success remaining on the trees at harvest time had been punctured by the weevils. Similar damage was experienced at Lanett, and in other parts of the state.

Three dipterous parasites were reared from pecan weevil larvae. These were *Myiophasia nigrifrons* Townsend, *Sarcophaga sima* Aldrich, and *Winthemia rufopicta* Bigot. The percentage of parasitism by these flies was found to be less than two per cent.

Two undetermined bacterial and two fungous parasites were found attacking the pecan weevil larvae. The two fungous parasites were *Metarrhizium anisopliae* (Metch.) Sorok., and *Sporotrichium bassiana* Bals. In preliminary tests, these have shown sufficient promise to warrant further experimentation on their use for the control of the pecan weevil.

HOME ECONOMICS

Calcium and Phosphorus Content of Alabama Vegetables. (Edna R. Bishop).—The influence of variety, age, soil type and fertilizer treatment on the calcium and phosphorus content of vegetable greens is being studied. Calcium is determined by permanganate titration and phosphorus by the Fiske and Subbarow colorimetric method. Analyses of different samples of a given vegetable have shown a variation of approximately 270 per cent in calcium and 200 per cent in phosphorus on a basis of edible portion. This variation has been found (1) to be greater

on the basis of dry weight than of edible portion, (2) to indicate a tendency toward an inverse calcium and phosphorus relationship, (3) to be slight with variety except that American varieties of turnip greens have a higher calcium content than Japanese varieties, (4) to be little influenced by age, (5) to be much affected by weather conditions, (6) to be influenced by the soil and fertilizer treatment. Turnip tops and tendergreen have a higher calcium and phosphorus content than Chinese cabbage.

HORTICULTURE AND FORESTRY

Grape Variety Studies. (O. C. Medlock).—During the winter of 1924-25 three plants each of fifty-one varieties of grapes were planted. Most of these varieties had been developed especially for southern conditions, but a few of the old standard varieties were also included. Some vines of twenty-two varieties were alive June 1, 1931, while all the vines of the other thirty varieties had died. The ten varieties most outstanding in vigor and production the first five years of the test are as follows: Dr. Collier, a blue grape of fair quality, ripening in midseason; Herbemont, a reddish purple grape of good quality, ripening late; Jacquez, a blue grape of fair quality, ripening late; Manito, a blue grape of poor quality, ripening early; Marguerite, a dark purple grape of good quality, ripening late; Concord, an old standard blue grape of good quality; Elvicaud, a red grape of fair quality, ripening in mid-season; Extra, a black grape of good quality, ripening late; Muench, a blue grape of good quality; and R. W. Munson, a blue grape of good quality, ripening in mid-season.

Pecan Storage. (O. C. Medlock).—Studies have been conducted on the storage of the Stuart and Frotscher varieties of pecan since January, 1929. Nuts of the 1928, 1929, and 1930 crops have been stored at ordinary humidity, high humidity, and low humidity at each of the following temperatures: 32°, 35°, 40°, 50° F., and at ordinary temperature of a sweet potato storage room.

Pecans lose in quality after a long period in storage at all temperatures and humidities tested, but they may be stored in an atmosphere of low humidity at 35° F. for more than two years without becoming distinctly rancid. When they are stored at ordinary temperatures and humidities, the quality becomes so low ten to twelve months after they are harvested that they are not desirable for food. At high temperature and high humidity a large percentage of the nuts mold within sixteen days. Pecans retain a higher quality when stored at a temperature of 35° F. or lower than at higher temperatures. The kernels retain a better color and flavor when stored at low humidity than at ordinary or high humidity. Perceptible amounts of free ammonia in the

storage atmosphere caused a darkening of pecan kernels within ten days.

Study of Native Blueberries. (O. C. Medlock).—In December 1924, a planting was made of native blueberry plants that had been selected the previous summer in the swamps of southeastern Alabama. A mulch of oak leaves and pine needles was applied around them covering an area with a diameter of about eight feet, and the sod between these areas was mowed frequently during the spring and summer; the plants have made good growth. The yield of berries varied from 0.01 to 10.50 pounds in 1930. The highest yielding plant has produced approximately three gallons of berries.

Variety and Date of Seeding Tests with Vegetables. (C. L. Isbell).—During the last three years tests have been underway with several of the common vegetables to determine the effect of variety and time of seeding upon the time of harvest and yield.

Carrots.—Plantings of several different varieties made during the last half of September compared with the same varieties planted one month later strongly indicate that much better results may be expected from plantings made in September. The varieties Chantenay, Danver's Half Long, and Rubican gave very good yields of carrots of fair to good quality. The varieties Careless and Nantaes are low yielders but good to excellent in quality.

Cowpeas for Table Purposes.—One year's results obtained from more than ten varieties indicate that it may be possible to have a supply of green peas for table use over a relatively long period either by making a single planting of several different varieties on the same date, or by making successive plantings of the same variety. The varieties California Black Eye (Extra Early Ram's Horn) and Extra Early Black Eye, are the earliest, followed by Dixie Queen Brown Eye (California Brown Eye), Cream Crowder, Speckled Crowder, Taylor (Early Crowder), Conch, Lady Pea, Virginia Black Eye, and White Crowder, in the order named.

Onions.—Plantings of several different varieties, including American and European types, were made during the falls of 1928, 1929, and 1930. The plantings were made in the field from seed sown during the last ten days of September and a month later.

All the October plantings failed due to poor germination, damping off, freezing, or because the plants did not get large enough for transplanting in time, or due to a combination of one or more of these causes.

All varieties of the September plantings of 1928 and 1930 went through the winter without being killed by freezes. The heavy freezes during December 1929, failed to kill any of the

plants of Early Red Weathersfield, Ohio Yellow Globe, Southport White Globe, White Portugal, and Egyptian Perennial Tree. All other varieties were damaged. The damaged ranged as low as two per cent with the Crystal White Wax to as great as ninety-nine per cent with the Early White Queen. The Baboza and White Queen varieties matured first, followed by the White Wax Bermuda, in about fifteen days. The Bermuda was about fifteen days earlier than most of the other varieties.

Radishes.—Late September and late October plantings of five winter varieties were compared in 1928, 1929, and 1930. The September plantings give very much greater yields. The Chinese Rose, White Chinese, and Round Black Spanish gave much larger yields of storage roots than the varieties Long Black, Spanish, and Sakurajima. The last named varieties mature much later than the others.

Sweet Potatoes.—Of the several varieties under comparison the Jerseys, Porto Ricos, and the Triumph are all heavy yielders. It appears impractical, if not impossible, to keep some varieties of the Jersey type, especially the Big Stem, free of diseases. Most of the varieties of the Jersey group dry out so much in storage that they become very much shriveled.

Fertilizer Experiments with Potatoes in South Alabama. (R. W. Taylor).—The yield summary of plots on Norfolk fine sandy loam that received complete fertilizers carrying different amounts of each nutrient is shown in Table 14. The nitrogen applied was derived $\frac{1}{2}$ from sulfate of ammonia, $\frac{1}{4}$ from cottonseed meal, and $\frac{1}{4}$ from nitrate of soda. Phosphorous was derived from superphosphate and potassium from muriate of potash.

The yield was greatly increased where the amount of nitrogen applied was increased from 30 pounds to 60 pounds per acre. The average yield where 60 pounds of nitrogen were applied per

TABLE 14.—Influence on Yield of Potatoes of Complete Fertilizers Carrying Different Amounts of Each Nutrient

Fertilizer treatment			Yield in bushels per acre			
Pounds per acre			Average 1930-31		4-yr. av. 1928-31	
N	P ₂ O ₅	K ₂ O	U. S. No. 1	U. S. No. 2	U. S. No. 1	U. S. No. 2
30	192	100	113	28	—	—
60	192	100	172	23	143	32
90	192	100	175	22	142	30
90	64	100	141	28	—	—
90	128	100	162	24	140	33
90	192	100	162	23	149	37
90	192	25	150	26	—	—
90	192	50	151	25	98	25
90	192	100	166	24	111	24

acre was as high as where 90 pounds were applied. The yield was increased where the amount of phosphoric acid applied was increased from 64 pounds to 128 pounds per acre, but an additional increment produced little or no increase. An increase in the application of potash from 50 pounds to 100 pounds per acre gave an increased yield of number one potatoes over the four-year period.

Spacing and Seed-Piece Test with Potatoes in South Alabama. (R. W. Taylor).—There were no significant differences in the four-year average yields of potatoes planted 12, 14, or 16 inches apart in rows 3½ feet apart. One and one-half ounce seed pieces have produced higher yields than either ounce or half-ounce seed pieces.

Effect of Fertilizer Treatment on Yield, Grade, and Quality of the Irish Potato. (L. M. Ware).—Studies for three years on the same plots comparing yield, grade, and quality of potatoes supplied different amounts of nitrogen, phosphorus, and potash derived from different sources in a basic application furnishing materials equivalent to 800 pounds acid phosphate, 400 pounds nitrate of soda, and 150 pounds muriate of potash, gave the following general results.

- (1) Storage studies at three different temperatures failed to show any great differences in keeping quality of potatoes produced under different fertilizer treatments, yet certain consistent differences at each of the three temperatures were found. Greatest losses from shrinkage in all cases occurred in potatoes produced from non-fertilized plots and smallest losses from potatoes from plots most heavily fertilized. Potatoes from plots receiving phosphorus and potash but no nitrogen consistently showed a relatively high shrinkage loss. Little differences in shrinkage were recorded between plots receiving a complete fertilizer deriving the principle ingredients from different sources. Potatoes from all treatments kept well.
- (2) Chemical analyses have established no consistent differences in composition of the tubers attributed to fertilizer treatment except where the treatment delayed maturity. Less mature tubers have run low in starch and high in moisture.

Influence of Fertilizer Treatment on Yield, Grade, and Quality of Strawberry. (L. M. Ware).—An extensive study was made of the influence of different fertilizer treatments on yield, grade, size of berry, sugar content, total acidity, H ion concentration, refractive index, firmness, and shipping quality of strawberries. Manure, nitrate of soda, and cottonseed meal were compared as sources of nitrogen; muriate and sulphate were compared as sources of potash; and comparisons were made of the influence of the application of different amounts and combinations of ni-

trogen, phosphorus, and potash. Treatments were duplicated on new ground and on old ground.

A critical examination of the data shows small yet consistent differences in the quality and characteristics of berries associated with certain treatments yet it remains that the most significant differences yet found are in yield, grade, and size of berry. In this experiment potash did not improve the shipping quality nor nitrogen significantly lower it.

SPECIAL INVESTIGATIONS

Increase of Root Nodules on Peanuts by Inoculation. (J. F. Duggar).—Although peanuts are usually supplied with some root nodules and hence regarded as requiring no inoculation, yet in 1930 the inoculation of both shelled and unhulled seed peanuts resulted almost invariably in large increases in the average number of nodules per plant.

On the plants grown from inoculated seed there was an average increase in total nodules per plant of 191 per cent when the seedlings were about six weeks old and of 231 per cent when they were about four months old. This increase in nodule numbers, at a harvest made four months after a planting made June 12, was accompanied by an average increase of 32 per cent in number of sound nuts per plant, of 24 per cent in the weight of sound nuts and of 23 per cent in the combined weight of tops, nuts and roots.

Effects of Sulfur and Phosphate on Nodule Numbers. (J. F. Duggar).—Separate applications were made of superphosphate, basic phosphate and hydrated lime, each in intimate contact with the seed and at rates of 400 pounds per acre of either superphosphate or lime and 600 pounds per acre of basic phosphate. With all of these there was a notable decrease in average number of nodules per plant, at least during the first six weeks of the life of the young peanut plant. On the other hand, dusting sulfur, applied at the rate of 200 pounds per acre in intimate contact with the untreated seed, was followed by notable increases in number of nodules. These increases were on successive dates, 17 per cent, 68 per cent and 81 per cent respectively in number of total nodules. When the number of large nodules per plant was made the basis of comparison between sulfur and untreated seed, the increase following the use of sulfur was 172 per cent and 245 per cent on successive dates of examination.

Inoculation of Korean and Perennial Lespedeza. (J. F. Duggar).—As heretofore reported for earlier years, Korean lespedeza (*L. stipulacea*) again in 1930 developed only a late and inadequate supply of root nodules, while Kobe, common, and Tennessee 76 lespedeza was each supplied with several times as many nodules

per plant. Treating the seed of Korean lespedeza with a culture made from its own nodules usually afforded a notable increase in the average number of nodules per plant.

When perennial lespedeza (*L. sericia*) was inoculated with a culture from its own nodules the plants averaged at the end of the season 65 nodules each, in comparison with an average of only 18 per plant where the seed had received no treatment.

Injury of Alfalfa by the Three-Cornered Alfalfa Hopper. (J. F. Duggar).—At Auburn first indications of injury in the season of 1930 were found May 5 and the first very numerous broods were hatched May 9-13. The percentage of alfalfa stems found to be girdled in the Black Belt at various dates was lower than in any recent year, a condition apparently associated with periods of extreme drouth.

Cost of Corn and Sorghum Silage in 1930. (J. F. Duggar).—On 22 fields, most of them cropped with sorghum, the average cost of producing and storing silage was \$4.13 on the basis of the same schedule of charges as tentatively used in earlier reports. On the same basis the average cost per acre for 1930 was \$26.92.

VETERINARY MEDICINE

The Susceptibility of the Guinea Fowl to Brucella Disease. (M. W. Emmell and I. Forest Huddleston—Michigan State College).—Guinea fowls were fed suspensions of each of two strains of the three species of *Brucella*. An enlarged spleen, a friable, congested and often slightly atrophied liver, congested kidneys, necrotic and hemorrhagic enteritis were produced by the infection. The microscopic lesions consisted of perivascular foci of hyperplasia of reticulo-endothelial cells in the liver, spleen, and lungs, hydropic degeneration and local necrosis of the hepatic cells, cloudy swelling intermingled with necrosis in the kidneys with hyperplasia of numerous glomeruli, and areas of congestion in the lungs and kidneys. The infection did not prove fatal within 120 days. Two cases of natural infection were found in which the birds exhibited similar lesions to those of experimental birds. The infection was traced to a herd of hogs with which they associated and in which a high per cent of the animals were affected with abortion disease.

A Study of the Intestinal Flora of Baby Chicks Affected with Pullorum Disease. (M. W. Emmel).—A study was made of the intestinal flora of naturally infected pullorum-positive chicks with particular reference to any relationship that may exist between *Salmonella pullorum* and organisms of the colon group. The colon organisms constituted an unweighted average of 32.35, 38.02, and 63.35 per cent of the bacterial flora of the duodenum, middle por-

tion, and cloaca, respectively. In the same chicks *Salmonella pullorum* constituted an average of 47.26, 47.61, and 19.63 per cent of the bacterial flora of the duodenum, middle portion, and cloaca, respectively. The inoculation of 24-hour broth cultures of *Salmonella pullorum* with colon organisms resulted in a reduction in the number of *Salmonella pullorum* per cubic centimeter from 189,600,000 to 32,000,000 after 24 hours incubation.

In fifteen chicks which recovered from pullorum disease *Salmonella pullorum* persisted in the feces of 13 chicks for one week, 8 chicks for two weeks, 3 chicks for three weeks, and one chick for five weeks after the climax of the outbreak.

The Differentiation of Pasteurella Avicida and Brucella Infections in the Fowl. (M. W. Emmel and M. L. Boevers).—These cannot be differentiated on the basis of the agglutination test alone as cross-agglutination exists between the *Brucella* and *Pasteurella* genera. However, the fowl shows a marked response in the production of agglutinins when exposed to *Brucella* organisms, but the reverse is true when exposed to *P. avicida*. The agglutination test apparently has some value in determining the presence of *Brucella* infection in a flock.

Acute or subacute fowl cholera can be differentiated from *Brucella* infection in the fowl bacteriologically by distinct differences in the nature and course of the two infections, as well as by differences in the microscopic pathology produced by the causal organisms. Localized *P. avicida* infection can be differentiated from *Brucella* infection by the macroscopic pathology produced about the head of birds by the former infection, *P. avicida*, as a general rule being readily isolated from such lesions.

Peritoneal Tumors in the Fowl. (M. W. Emmel).—A study has been made of the pathology of peritoneal tumors in the fowl. While these tumors are not of common occurrence, their similarity to the intestinal tubercles of tuberculosis is such that a study of their pathology is warranted. Such tumors occur on the serosa and vary in size up to 4 mm. in diameter. The mesentery is involved in some instances. Occasionally there may be general thickening of the serosa with very little tendency to the formation of neoplasms. Ruptured egg yolks and infestation with the tapeworm, *Davamea Proglotina* have been found to be an apparent exciting factor. In the cases studied the origin of such neoplasms were found to be in the mesothelium or in the subepithelial lymph channels. In either instance both seem to become finally involved in the process.